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Journal

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INSIDE THIS ISSUE

The Dresden (Ontario) H6 Chondrite

New Horizons: Mission to Pluto, Charon, and Beyond

Wilderness Stargazing

April / avril 2006

Journal

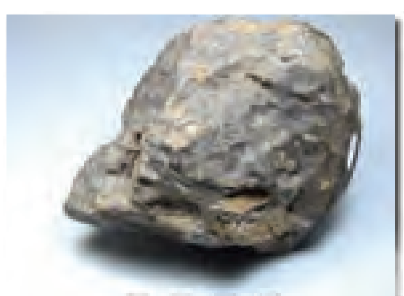
Vol. 100, No. 2 Whole Number 717

contents
table des matières

FEATURE ARTICLES/ARTICLES DE FOND

COLUMNS/RUBRIQUES

Wilderness Stargazing
p. 75

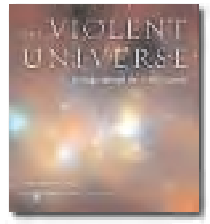


The Dresden (Ontario) H6 Chondrite
p. 64

A Moment With…Dr. Alan Hildebrand
p. 92

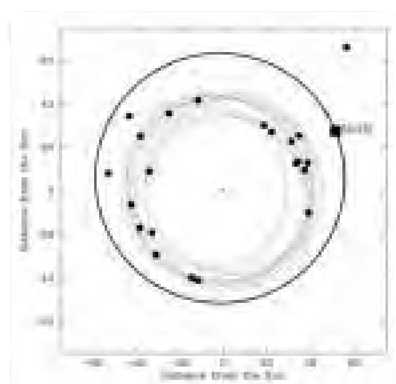
DEPARTMENTS/DÉPARTEMENTS

Cover photo by Albert Saikaley.
Albert comments, "The secret of taking a really good M51: if at first you don't succeed, try, try again." This image was his fourth attempt in as many years, captured over two sessions in May 2005. Total exposure for the LRGB image is 3.5 hours. Telescope: Celestron 11" f/6.3 on a Losmandy G11 mount. Camera: ST-10SME. Guider: A07.



Book Review: The Violent Universe
p. 97

ACROSS THE RASC
DU NOUVEAU DANS LES CENTRES



News Notes
p. 60

Editorial

by Richard Huziak, Saskatchewan Light-Pollution Abatement Committee (Huziak@sedsystems.ca)

Who Will Protect Your Night Sky if You Won't?

A quick perusal of RASC Centre Web sites shows that most astronomy clubs in Canada do not have active light-pollution abatement (LPA) programs. It seems that out of 27 RASC Centres and a larger number of independent clubs, fewer than a dozen have active LPA programs, at least as far as Web sites advertise.

Complaining about local light pollution seems to be a recurring topic on RASClist, the RASC's Internet discussion list, but it seems that words are always much easier than real action. Will your observatory or observing field survive the onslaught of unprotected lighting in the next ten years? *Who will protect your sky if you won't?*

From personal experience, lobbying councils, mayors, MPs, MLAs, RMs, businesses, and developers to make change, or worse yet, to enact laws that protect the sky, is a full-time job that is frustrating and downright depressing at times. But when even small successes are achieved, it becomes worth it! Your reward is a darker sky, or at least one that will stay a bit darker for a bit longer.

Not every club has the drive or the resources to run an active LPA program. But a lobby program is not all that can be done. Simple awareness goes a long way toward changing attitudes about nighttime lighting and its destructive ways. Information is everything! Most citizens have never heard of light pollution and have no idea that lights can be bad. It's not what they've been told for most of their lives. Most still believe that they are safer at night and that crime is reduced through all-night lighting. Yet, most come on side once they know that wasted energy production causes unnecessary pollution and when the safety myths are dispelled.

Saving the sky also goes beyond your local astronomy club. If you belong to a different type of club — a nature society, an environmental club, or a service club — get them to acknowledge and watchdog the destruction of the night sky. Get them to include light pollution as a problem they will consider when addressing other environmental action plans. Write letters to your newspaper, or city, or RM councils as a citizen complaining about bright, glaring, wasteful, polluting lights. Talk to your local schools — many have environmental clubs. Write to your provincial or federal Ministers of the Environment and tell them to do their jobs! And please take time to advertise your programs and successes by writing about

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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them in the *JRASC* so that we can all benefit from your experience.

One important and simple task is to add a light-pollution section to your Centre's Web sites so that everyone who visits the site sees that we astronomers are concerned about the disappearing future of the night sky. You don't need an active program — just an informational page. There are thousands of resource pages you can find all over the Internet to get this Web page up and running, and many great links from other RASC Centre and National Web sites.

The destruction of the night sky can be stopped, but to do it, we'll all have to pitch in a bit.

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To join the list, send an email to `listserv@ap.stmarys.ca` with the words "subscribe rascals Your Name (Your Centre)" as the first line of the message. For further information see: `www.rasc.ca/computer/rasclist.htm`

News Notes
En Manchettes

THE MYSTERIES OF "BUFFY": 2004 XR 190

by Martin Beech, Campion College, University of Regina (Martin.Beech@uregina.ca)

A team of astronomers working in Canada, France, and the United States has discovered an unusual small body orbiting the Sun beyond Neptune, in the region of the Kuiper belt. This new object is twice as far from the Sun as Neptune and is roughly half the size of Pluto. The body's highly unusual orbit is difficult to explain using previous theories of the formation of the outer Solar System.

Currently 58 astronomical units (AU) from the Sun, the new object never actually approaches closer than 50 AU. In contrast, almost all Kuiper-belt objects (KBO) discovered beyond Neptune lie between 30 and 50 AU. The main Kuiper belt appears to end at 50 AU and the few objects known to lie beyond this distance have very high-eccentricity (non-circular) orbits. Most of these high-eccentricity orbits are thought to be the result of Neptune "flinging" the object outward by a process known as a gravitational slingshot. Because this new object does not approach closer than 50 AU, a new theory is needed to explain its orbit. Complicating the problem, the object's orbit also has an extreme tilt, being inclined at 47 degrees to the ecliptic.

The new body, which received the official designation 2004 XR 190, was discovered during routine operation of the Canada-France Ecliptic Plane Survey (CFEPS) running as part of the Legacy Survey on the Canada-France-Hawaii Telescope. For now the discoverers are using the temporary nickname "Buffy" to identify the new object, although they have proposed a different official name in keeping with normal procedures for naming such discoveries.

Buffy's existence was extracted from the mountain of Legacy Survey data (about 50 gigabytes per hour of operation) by powerful computers that comb through the telescopic images and produce a list of hundreds of candidates. Astronomers then sift through the list of candidates to confirm the initial detection.

Astronomer Lynne Allen of the University of British Columbia was the first to lay eyes on the new object, confirming the initial identification in the course of processing CFEPS data from December 2004. "It was quite bright compared to the usual Kuiper-belt objects we find," said Dr. Allen, "but what was more interesting was how far away it was." The object's brightness implies it is likely between 500 and 1000 kilometres in diameter. Buffy is thus a very large Kuiper-belt object, though about half a dozen are larger.

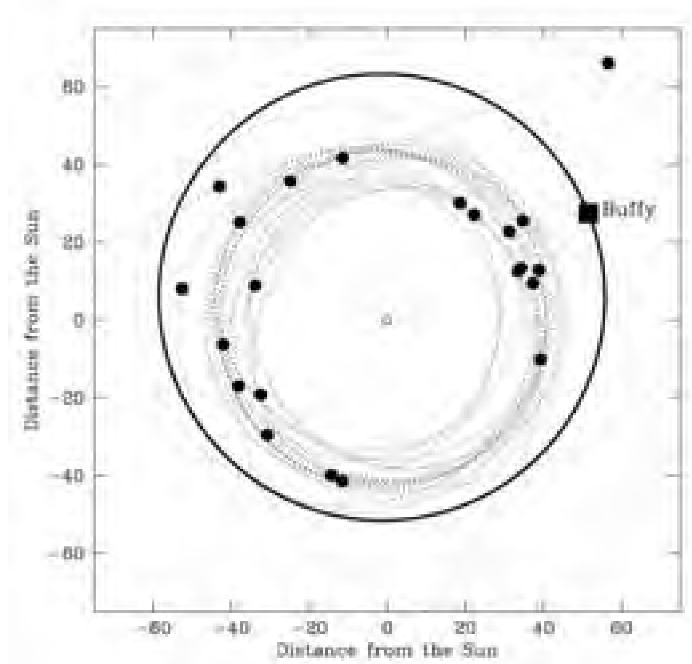


Figure 1 – Plan view of the near-circular orbit (solid line) of "Buffy." The orbits of several additional Kuiper-belt objects are also indicated. The scale is in astronomical units.

"We immediately realized that the object was about twice as far as Neptune from the Sun and that its orbit was potentially nearly circular," said UBC professor Brett Gladman, who noticed the unusual nature of the object when determining its orbit, "but further observations were required."

One to two years of observation of a Kuiper-belt object are required before its orbit can be precisely measured. The first additional observations of Buffy came in October 2005 when Gladman and Phil Nicholson of Cornell University used the Hale 5-metre telescope to re-observe the object. The new measurement not only proved that the orbit was extremely tilted, inclined at 47 degrees to the plane of the Solar System, but also confirmed that its circular orbit and great distance made it unlike any other previously known object.

Additional measurements of Buffy's position on images from telescopes at Kitt Peak National Observatories in Arizona by team members Joel Parker (Southwest Research Institute), as well as J.J. Kavelaars (National Research Council of Canada, Herzberg Institute of Astrophysics), and Wes Fraser (University of Victoria) through November 2005 refined the estimate for its closest approach to the Sun. Further measurements, to refine the orbit, were then provided by the CFHT Legacy Survey project. Astronomers will need to wait until February 2006 to measure still finer details of Buffy's orbit.

The team has reported their find to the Minor Planet Center, the clearinghouse for astronomical measurements of new minor planets. "To find the first-known object with a nearly circular orbit beyond 50 AU is indeed intriguing," reacted Brian Marsden, director of the MPC.

Although it is neither the smallest, largest, nor most distant object discovered in this region, the highly unusual orbit of the new Kuiper-belt object presents a considerable challenge to current theories of the evolution of the Solar System. Only one other detected object, Sedna, remains further than 50 astronomical units from the Sun throughout its entire orbit. However, Sedna is on a very elliptical orbit, swooping in to 76 AU before traveling back out beyond 900 AU. In contrast, Buffy spends all of its time in the narrow range between 52 and 62 AU from the Sun.

The few other Kuiper belt objects that spend most of their time beyond 50 AU are also on very elliptical orbits, and almost all approach within 38 AU of the Sun at perihelion. At this distance the bodies are subject to gravitational scattering by Neptune and form a group of objects known collectively as the "Scattered Disk."

Prior to the discovery of Buffy, a few other Kuiper-belt objects had been discovered that spend much of their time beyond 50 AU like those in the "Scattered Disk," yet did not approach within the gravitational reach of Neptune. This group is named the "Extended Scattered Disk." Two of its members are 1995 TL8 and 2000 YW134, both of which approach to within 40 AU of the Sun but have elliptical orbits that take them back out beyond 60 AU. Two more extreme examples of the Extended Scattered Disk are 2000 CR105, which approaches to 44 AU, and Sedna, which never comes closer to the Sun than 76 AU.

Due to their large eccentricities, these objects are likely to have been strongly perturbed by something, although it could not have been Neptune because they do not come close enough to be scattered by that planet's gravitational force. As both Sedna and 2000 CR105 also travel beyond 500 AU from the sun, one theory is that after being scattered by Neptune, a passing star could have pulled their closest approaches away from the Sun.

Buffy is clearly a member of the "Extended Scattered Disk." However, Buffy's almost circular orbit makes it stand out from the other members. In addition, Buffy's large orbital tilt is not so easily explained by the passing-star idea. If a star could have affected Buffy so strongly, it should also have disrupted much of the main Kuiper belt as well. Since astronomers do not detect that strong disruption, a more complex theory is needed to explain Buffy's orbit.

The elusive explanation may lie in side-effects from rearrangements of the Solar System early in its history. One possibility is that as Neptune's orbit slowly expanded in the young Solar System, complex gravitational interactions could have caused some Kuiper-belt orbits to circularize and tilt. While Buffy's orbit could have been created this way, this theory would not seem to explain 2000 CR105 and Sedna. This new discovery is exciting because it causes us to rethink our understanding of how the Kuiper belt formed.

Although several theories can explain the orbit of individual objects, reproducing the entire ensemble of known objects with one process poses a difficult challenge to current Solar System models. Because unusual objects like Buffy are very rare, astronomers are still scratching in the dark corners of the Kuiper belt for an explanation. Future large-scale surveys that systematically explore the Kuiper belt may be the only way to unlock the mysteries of what happened early in the history of our Solar System.

A 3D simulation of Buffy's orbit can be located at the following URL: `www.cfeps.astrosci.ca/4b7/Buffy-simulation.mpg`, while more technical information on Buffy can be accessed at `www.cfeps.astrosci.ca/4b7/techie.html`.

"BIGGEST BLUNDER" TURNS OUT TRUMPS

The genius of Albert Einstein, who added a "cosmological constant" to his equation for the expansion of the Universe but later retracted it, may be vindicated by new research.

The enigmatic dark energy that drives the accelerating expansion of the Universe behaves just like Einstein's famed cosmological constant, according to the Supernova Legacy Survey (SNLS), an international team of researchers in France and Canada that collaborated with large-telescope observers at Oxford, Caltech, and Berkeley. Their observations reveal that the dark energy behaves like Einstein's cosmological constant to a precision of 10 per cent.

"The significance is huge," said Professor Ray Carlberg of the Department of Astronomy and Astrophysics at the University of Toronto. "Our observation is at odds with a number of theoretical ideas about the nature of dark energy that predict that it should change as the Universe expands, and as far as we can see, it doesn't." The results will be published in an upcoming issue of the journal *Astronomy & Astrophysics*.

"The Supernova Legacy Survey is arguably the world leader in our quest to understand the nature of dark energy," said study co-author Chris Pritchet, professor of physics and astronomy at the University of Victoria, in BC.

The researchers made their discovery using an innovative, 340-million-pixel camera called MegaCam, built by the Canada-France-Hawaii Telescope consortium and the French atomic-energy agency, Commissariat à l'Énergie Atomique. "Because of its wide field of view — you can fit four Moons in an image — it allows us to measure simultaneously, and very precisely, several supernovae, which are rare events," said Pierre Astier, one of the scientists with the Centre National de la Recherche Scientifique (CNRS) in France.

"Improved observations of distant supernovae are the most immediate way in which we can learn more about the mysterious dark energy," adds Richard Ellis, professor of astronomy at the California Institute of Technology. "This study is a very big step forward in quantity and quality."

Study co-author Saul Perlmutter, physics professor at the University of California, Berkeley, says the findings kick off a dramatic new generation of cosmology work using supernovae. "The data are more beautiful than we could have imagined ten years ago — a real tribute to the instrument builders, the analysis teams, and the large scientific vision of the Canadian and French science communities."

The SNLS is a collaborative international effort that uses images from the Canada-France-Hawaii Telescope, a 3.6-metre telescope atop Mauna Kea. The current results are based on about 20 nights of data, the first of over nearly 200 nights of observing time for this project. The researchers identify the few dozen bright pixels in the 340 million captured by MegaCam to find distant supernovae, then acquire their spectra using some of the largest telescopes on Earth — the Frederick C. Gillett Gemini North Telescope on Mauna Kea, the Gemini South Telescope on the Cerro Pachón mountain in the Chilean Andes, the European Southern Observatory Very Large Telescopes (VLT) at the Paranal Observatory in Atacama, Chile, and the Keck telescopes on Mauna Kea. The SNLS is one component of a massive 500-night program of imaging being undertaken as the CFHT Legacy Survey.

A RECORD-BREAKING YEAR FOR METEORITES

The discovery of four new meteorites in 2005 makes it a record-setting year for recovering rocks from outer space in Canada and also confirms a University of Calgary scientist's belief that an extraordinary concentration of meteorites left behind after the last Ice Age is located in southeastern Manitoba.

"Scientists have been collecting meteorites in Antarctica for more than two decades where glaciers have concentrated them along the edges of the continent. Many have postulated that the continental ice sheet that covered Canada might also have done this," said U of C planetary scientist Dr. Alan Hildebrand, co-director of the Prairie Meteorite Search. "That another meteorite was found with relatively little effort pretty much establishes that an unusual concentration of meteorites does exist in eastern Manitoba, and the continental glaciers are the obvious culprit to have put them there."

After becoming the first Canadian to discover two separate meteorites last summer, Winnipeg-based rock collector Derek Erstelle has now extended the Canadian record by locating fragments of weathered iron that the Prairie Meteorite Search has shown to be another new meteorite from the bush near the Ontario border. The discovery is exciting news for Manitoba's astronomy community.

"We're obviously very excited about these meteorite discoveries, and we hope that this signals even more discoveries in the future," said Scott Young, manager of the Manitoba Museum's planetarium and science gallery. "Manitoba is under-represented in the meteorite game, so this is our chance to climb the meteorite ladder."

Erstelle's latest find happened in October while he was testing Hildebrand's theory that his previous two meteorites were found relatively close together in the forest because the rocks dropped there when the glaciers that covered much of North America were retreating about 12,000 years ago. The third meteorite is a collection of heavily rusted iron fragments that were found about 40 kilometres from Erstelle's previous two discoveries north of the town of Pinawa.

"I try to mimic animal behaviour when I'm hunting," Erstelle said of his effective meteorite-hunting technique. "For meteorite searching I sit up high like a raptor and scan the exposed gravel banks with binoculars for unusual rusty spots. Then I check each one to see if something unusual is there."

Erstelle found the newest specimen on a gravel bar of the Whiteshell River just above where it empties into Lone Island Lake in the Whiteshell Provincial Park, about 100 km east of Winnipeg. The Lone Island Lake meteorite is the 8th meteorite to be discovered in Manitoba, the 9th meteorite identified by the Prairie Meteorite Search, and the 68th new meteorite to be recovered in Canada.

Erstelle was able to recover about five kilograms of material after locating the crumbling remains of the meteorite with his metal detector. "The rusty meteorite was already breaking to pieces, but was triggering my metal detector. I dug to get additional pieces and eventually screened the gravel around where the pieces were to get all that I could," he said.

Hildebrand, holder of a Canada Research Chair in Planetary Sciences, said he was initially skeptical Erstelle had found another meteorite. "Derek's recent discovery is very weathered, so much so that when I received the samples I didn't think that they were meteorites," Hildebrand said. "But I couldn't tell what type of rock they were so I cut one, and to my surprise found metal inside. We checked it with the microprobe and the metal contained nickel confirming its origin."

In July, the Prairie Meteorite Search confirmed that two fragments of a meteorite Erstelle found about 40 kilometres away near Bernic Lake in 2002 were from a meteorite separate from a similar-looking specimen he collected near Pinawa in 1998 or 1999. Hildebrand determined that the rocks were found where two lobes of the ancient Laurentide ice sheet met about 11,500 years ago, providing an explanation for their remarkably close proximity. Hildebrand said further tests will be done to determine how long the rocks have been on Earth and to see if more meteorites can be found in the area.

"If these meteorites fell on the ice sheet, they would have to have been on Earth for 12,000 years or longer," Hildebrand said, noting that Erstelle's latest find is very weathered, indicating that it fell to Earth long ago. "We now have to make a plan for the Prairie Meteorite Search to further investigate the region next summer, and I expect Manitoba could well become Canada's pre-eminent meteorite province during 2006."

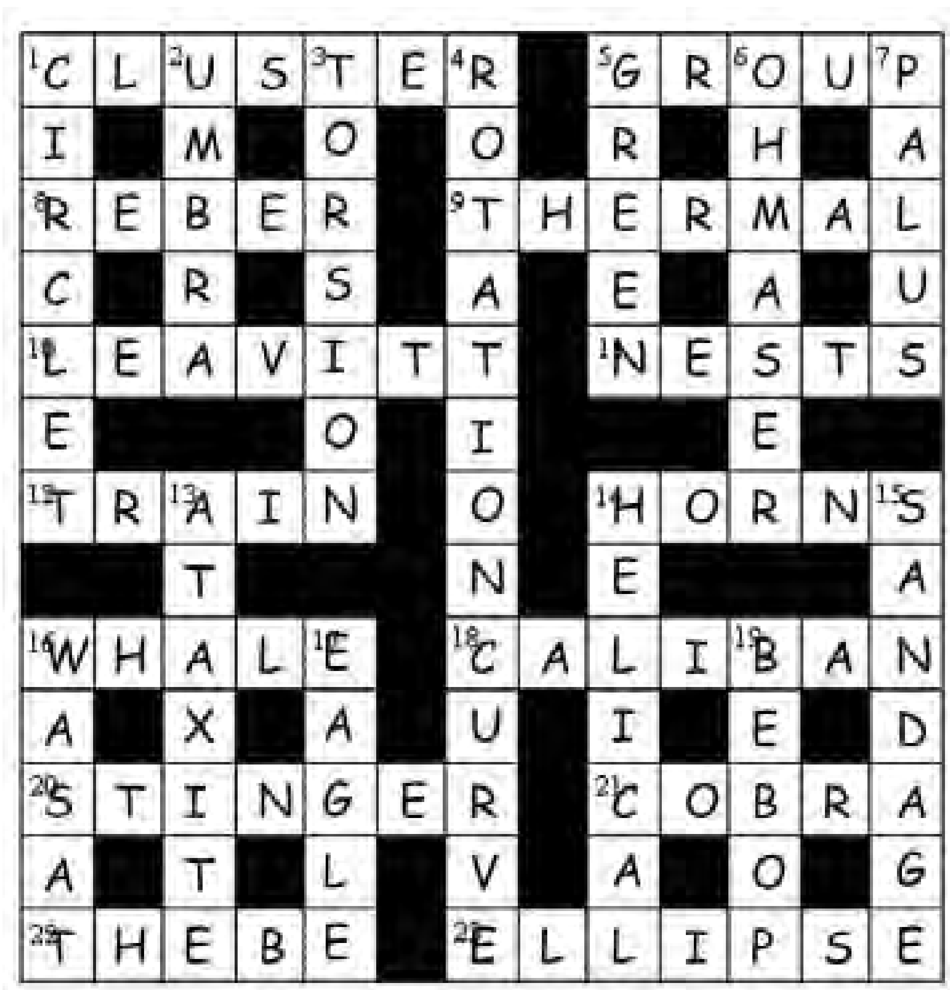
Young is also hopeful more meteorites will be found in Manitoba next year. "I encourage people to keep an eye out for unusual looking rocks, and bring them to someone who can identify them - the meteorites are out there somewhere."

The Prairie Meteorite Search is led by Hildebrand, Dr. Peter Brown from the University of Western Ontario, and Dr. Martin Beech from Campion College at the University of Regina. They are all members of the Meteorites and Impacts Advisory Committee (MIAC) to the Canadian Space Agency. MIAC is Canada's volunteer group charged with the investigation of fireballs and the recovery of meteorites. The Canadian Space Agency funded most of the project's field costs for the summer of 2005. Additional information about the Prairie Meteorite Search is available on the project's Web site: `www.geo.ucalgary.ca/PMSearch`

Astrocryptic

by Curt Nason, Moncton Centre

We present the solution to last issue's puzzle:



Feature Articles
Articles de Fond

The Dresden (Ontario) H6 Chondrite

Part I: Fireball Observations, Recovery and Sale, Field Searches, and Tribute

by Howard Plotkin, Department of Philosophy, University of Western Ontario, London, Ontario, Canada N6A 3K7 (hplotkin@uwo.ca)

Abstract

The fall of a meteorite is often a startling and dazzling spectacle. Observers have reported brilliant and colourful flashes that light up the night sky like broad daylight, one or more explosions, and sizzling or rumbling sounds as it roars overhead. Near the actual fall site, a whistling or sputtering sound is often heard, and then the dull thud of the impact as the meteorite hits the ground. On rare occasions, meteorites have landed so close that they terrified the observer beyond any experience ever encountered. Such was the case with the Dresden meteorite, which fell on the night of July 11, 1939. The story behind the fall, retrieval, and sale of this meteorite is remarkable, involving dignity and poignancy, opportunism and greed, and finally recognition and redemption. Extensive research combined with three field searches led to the recovery of some previously unknown fragments of the meteorite, and a long-overdue tribute to Dan Solomon and the Dresden meteorite featured some pleasant surprises for the Solomon family.

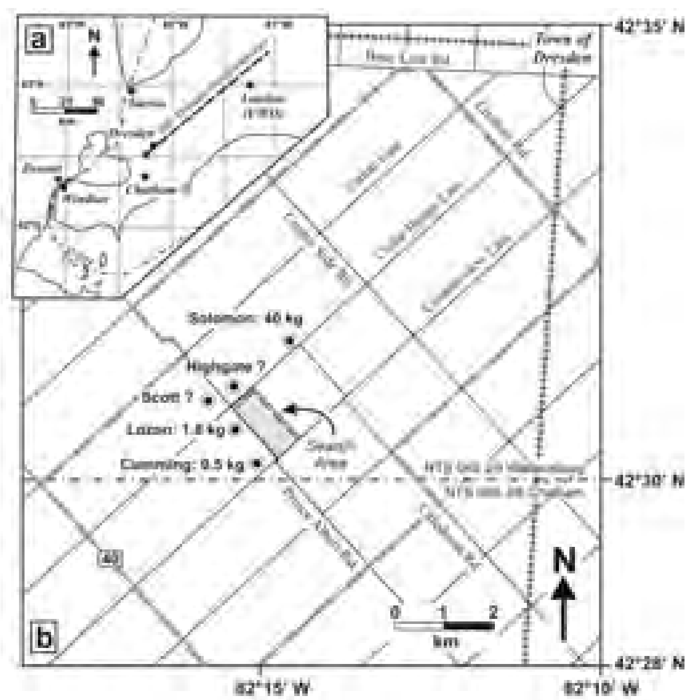


Figure 1 – a) The likely trajectory of the Dresden fireball across southwestern Ontario. The fireball was observed to pass slightly to the north of London, and ultimately produced meteorites 10 km southwest of Dresden, Ontario; b) Locations and masses of the recovered fragments within the Dresden strewnfield. Also indicated are the area within which information flyers were distributed during July and August of 2003 (area bounded by thick dashed line), and the area within the strewnfield, which was searched in May 2004 (diagonal hatched box, searched along drainage ditches that border its northeast and northwest sides). Find locations marked with "?" are unconfirmed.

Introduction

A spectacular fireball roared across the sky in southwestern Ontario as dusk fell on the night of July 11, 1939 and was seen by thousands of persons there and in Michigan, Ohio, Wisconsin, and even as far away as Pennsylvania (Fig. 1a). The fireball underwent three explosions, and ended up dropping a ~40-kg meteorite in the sugar-beet field of Dan Solomon, about 10 km southwest of Dresden, as well as several small fragments in nearby fields (Fig. 1b). The meteorite, known officially as the Dresden (Ontario) meteorite, is the second largest individual meteorite from Ontario and the fourth largest from all of Canada. Through an interesting route it ended up at the University of Western Ontario (UWO) and was put on display in the Biology and Geology Building.

I have always had a fascination with meteorites, and on numerous occasions following my academic appointment to UWO in 1970 I would go over to admire the rock's rugged beauty. Since Dresden is less than a two-hour drive from London, I often speculated (naively, as it turned out) that it would be an easy matter to go there and search the fall area for additional fragments of the meteorite, and (correctly) that it would be great fun to do so. This idea remained on the back burner of my mind for many years until it was brought to the fore by a remark made at the 2002 Annual Meeting of the Meteorites and Impacts Advisory Committee to the Canadian Space Agency (MIAC). MIAC is a small group of volunteer scientists (and one historian of science — me) charged with the investigation of Canadian fireballs and the recovery of meteorites. At that meeting, MIAC

Chair Alan Hildebrand of the University of Calgary suggested that "...the sites of past [meteorite] finds and falls should be revisited once every decade. Dresden (Ontario), for instance...should perhaps be examined anew."

That served as a clarion call to me. Not only had I developed a decades-long special kinship with this meteorite, but through my extensive research on meteorite hunter/collector/dealer Harvey Nininger I was well aware of how rewarding the strategy of revisiting known strewnfields could be. I decided the time had come for me finally to take the plunge, and I endeavoured to find out as much as I could about the Dresden meteorite and organize a search party to try to locate more of its fragments. In the pages that follow, I relate the fruits of that endeavour.

Observations of the Fireball

To most persons who saw it, the fireball with its flaming tail that lit up the night sky "just as in broad daylight" shortly before nine o'clock was dazzling and startling. Some witnesses described the unfamiliar apparition as "a ball of fire" or "a fiery tear-drop"; others said it looked like "a giant sky-rocket." Since many persons who witnessed the event were farmers, they described the object in familiar terms, saying it resembled "a large egg," was "pear-shaped," or "in the shape of a large parsnip." Some reported hearing a sizzling noise, while others heard a loud, thunderous rumbling as it shot seemingly close overhead and exploded. Startled viewers swamped newspaper offices and police stations with calls asking about the strange sight — was it a belated Fourth-of-July sky-rocket, some strange form of lightning, or an airplane crashing in flames? Local astronomers, however, quickly pointed out the true explanation of the phenomenon.

A detailed description of the meteor was given by the Rev. W.G. Colgrove, the enthusiastic President of the London Centre of the Royal Astronomical Society of Canada, who happened to be on the UWO campus when the meteor flashed by. His description (Colgrove, 1939; p. 301), being that of an experienced astronomical observer, is especially noteworthy:

> ...suddenly a great flare from the north-east lighted up the lawns and trees all around us. It was the passing of an unusually bright meteor which immediately exploded high in the air and somewhat behind us and then, shooting a little to the north overhead, whizzed toward the south-west leaving a trail of bluish-green light about 5 degrees wide and extending from north of Vega to near Spica. No sooner had it reached a point apparently half way across the campus than it burst again and was followed by a similar band of orange-red light of equal dimensions. Finally it burst a third time and disappeared over the tree-tops on a distant hill. During its entire course the meteor itself shone as an intensely-brilliant object apparently about the size of a baseball six feet away and surrounded by a spherical yellowish glow as large as a football and shot through with short streamers of different colours. At each explosion a large puff of ashy smoke about ten degrees across arose and remained for nearly an hour in the air. The main feature lasted only about four seconds, but it was the grandest moving sky-picture I have seen since the Great Comet of 1882.

Although Colgrove described the meteor as moving from the northeast towards the southwest, there was no consensus on this, as various persons firmly stated it had traveled towards virtually every point on the compass. Viewers from Ontario claimed it moved in a more or less southerly direction, while viewers from the U.S. held it moved in a more northerly direction. This seems to corroborate the view of an unnamed UWO "authority" (undoubtedly H.R. Kingston, the Head of the Department of Mathematics and Astronomy, who took a keen interest in the meteor) who theorized (*Globe and Mail*, July 12, 1939) that "the meteor was falling practically straight down, which accounted for the difference in direction reported." Almost everyone thought the object fell a short distance from them, perhaps only a few kilometres away.

Recovery and Sale of the Meteorite

The first recovered fragment of the Dresden meteorite was a small piece reported to weigh about 1 lb (454 g) dug out of the ground by Bruce Cumming on his sugar-beet farm, about two km south of Solomon's farm (Fig. 1b). Cumming reported (*Chatham Daily News*, July 12, 1939) that he and his family were attracted outdoors when the entire countryside was lit up by the glare of the falling meteor. He reported hearing a roar "like thunder" when it seemed to pass directly overhead, then "a strange noise like the staccato firing of a machine gun, or the sputtering of an airplane engine," and then a "dull thud," as the meteorite hit the ground about 100 metres from his house. The family quickly formed a search party, and headed out in the direction the noise seemed to have come from. Their dog Shep accompanied them and led them directly to the spot where the meteorite had landed and "buried itself to the level of the dirt and mashed one or two small sugar beets to a pulp."

The main mass of the meteorite landed in Solomon's field, only 200 metres from where his wife Hazel was standing with their children (Fig. 1b). Her description of the event (Anon., 1939) clearly reveals how terrifying it was for her:

> My little girl, two years old, saw it first, coming out of the northern sky. I was weeding in my garden at the time. When I first looked up it was about the size of a baseball. It kept getting bigger and bigger until it was about the size of a bushel basket. I started to run toward the field at the back of the house. I was too scared to know what I was doing. When it got directly over me it stopped and made a noise just like a big rotten egg being broken — a sort of hollow plop. The thing shot off toward the west. Just at the same instant or maybe a second afterward, I heard a

terrible noise in the field right ahead of me. It sounded like a big airplane tearing along the field. That scared me worse than ever and I turned and ran back toward the house. My four children were with me. My husband returned from Dresden a few minutes later, but I wouldn't let him go to the field until [the following] morning.

Figure 2: a) Dan Solomon digs a two-metre deep hole to retrieve the main mass of the meteorite; b) Four Solomon children look on with fascination as their father digs out the meteorite (left to right: Florine, Gertrude, Wilfred, and James); c) Beth Ross, the sister of Charlie Ross, the editor of the *Dresden Weekly News* who helped Solomon extricate the meteorite, scrubs the meteorite clean; d) The meteorite after its scrubbing. Photos by Charlie Ross. I thank Carol Richmond and Jan Meloche of the Dresden Public Library for locating these photos in an album of Dresden historical photographs collected by Don "Gummer" Spearman, and for allowing me to reproduce them.

On the morning of July 12, Dan Solomon set to work to retrieve the main mass of the meteorite. He found that it had made a hole 30 cm by 45 cm; dirt was piled up all around the hole and chunks of earth were thrown 13 metres away. He enlarged the hole and began digging (Fig. 2a). At about two metres, the top of the meteorite became visible. His children looked on with fascination (Fig. 2b), as did a crowd of interested neighbours, including Charlie Ross, the young editor of the *Dresden Weekly News,* who had raced to the scene. Ross helped Solomon hook a chain around the meteorite, and with neighbours' help they were able to extricate it from its hole. In return for his help, Solomon allowed Ross to take the meteorite, described as being the size of a "field watermelon," to Dresden where he weighed it, cleaned it, and put it on display in the front window of his office. (Figs. 2c, d)

Later that day, Cumming's neighbour Henry Lozon reported he had recovered a fragment weighing about 5 lbs (2270 g) 80 metres from his house, and it was rumoured that two other nearby neighbours, A.V. Scott and George Highgate, had also dug up fragments of the meteorite on their farms (Fig. 1b). According to a report in the *Globe and Mail* (July 13, 1939), they "were awaiting offers" for their specimens.

Figure 3 – Luke Smith (right) and his friend Marshall McFadden admire the meteorite resting on the porch step between them. Later that day, Smith persuaded Solomon to sell him the meteorite for $4.00. Photo by Charlie Ross.

Solomon didn't have long to wait for an offer for his 88.25-lb (40.07-kg) meteorite. Luke Smith, a former Chatham dentist turned oil and gas prospector, and his friend Marshall McFadden saw the meteorite as it was being cleaned (Figs. 2c, 3), and quickly paid Solomon a visit. Smith decided (*Toronto Daily Star,* July 13, 1939) he wanted to purchase the meteorite: "I thought an oil man shouldn't miss a chance to get that close to heaven. Besides, it's a nice relic." According to one story (*ibid*), he was told that someone had already offered Solomon $3.00 for the "souvenir," so he "raised the ante" to $4.00. According to Solomon's son Wilfred (pers. comm.), Smith and McFadden pestered Solomon incessantly to sell the meteorite. Solomon, by all accounts a very gentle, soft-spoken man, gave in to this pressure, and agreed to sell it to Smith for $4.00.

But within a very short time, Solomon began to realize how terrible a deal he had made. C.A. Chant, the Director Emeritus of the David Dunlap Observatory in Richmond Hill, reported the next day (*Globe and Mail,* July 13, 1939) that a meteorite "...in good condition and the size described was worth any day on the open market upward of $200." Hazel Solomon (*Chatham Daily News,* July 14, 1939) was understandably distraught on hearing this: "Do you suppose that we will be able to get it back?...I don't know what Dan was thinking of when he sold it for four dollars...I've been mad at him ever since. I think he must have been worrying over some troubles that we have, and didn't really know what he was doing." The newspaper article carrying this story went on to poignantly relate "Last evening Solomon traveled into Chatham in his antiquated car to the palatial home of Smith in a vain attempt to regain possession of the meteorite."

As various institutions and universities — including UWO and the University of Toronto — quickly expressed their interest in the meteorite, Smith realized (*Chatham Daily News,* July 14, 1939) that the "sudden boom in the meteorite market" might reward him with a huge profit on his investment. He immediately retrieved it from the *Dresden Weekly News* window and brought it home with him. "This thing is getting valuable now and I don't want to take any chances." When asked if he was keeping it in a strong box, he replied: "I think I can look after it...I'll sleep right beside it and I'll have an automatic under my pillow, too." However, he didn't keep it with him for long. On the following day, seeking free publicity for the meteorite, Smith loaned it to the *Toronto Daily Star* for display in their window.

Newspaper accounts about the meteorite appeared daily. So did hordes of motorists, some from as far away as Ohio, who lined the concession road in front of Solomon's farm for days on end, eager to see the meteorite. Although they were disappointed to find out that it was no longer there, many helped themselves to small chips of the meteorite that had splattered off when it plowed into the ground, or had been rubbed off it by the chain used in its excavation. Wilfred Solomon remembers (pers. comm.) selling small chips to passing motorists for a few pennies each. Many of the tourists were from the U.S., prompting one newspaper (*London Free Press,* July 22, 1939) to wryly note: "...American tourists have gone home with a large number of...fragments of the recent spectacular meteor. This addition to Canada's tourist income will never be known, probably."

At least two larger pieces were also broken off the meteorite prior to its removal from Solomon's farm. According to the *London Free Press* of August 10, 1939, one of these pieces, weighing one-and-a-half pounds (681 g), was taken by Morley McKay, owner of Kay's Café, a popular Dresden restaurant. When Rev. Colgrove and G.H. Reavely of UWO's Department of Geology visited Dresden July 13 on a "Siderolite Scouting Tour," McKay donated this piece to UWO. The condition of his gift was that the university would cut it in half, polish one face, and return it to him; the other half was "his gift to the district's chief centre of higher learning."

Smith was furious over the "thefts" of these pieces and appealed for their return. As he waited to see how much he could get for the sale of the meteorite, turning down offers of $200 from UWO and the University of Toronto, he threatened (*London Free Press,* August 10, 1939) to cut it into eight fragments, polishing one face of each and engraving on it the date of fall, the name by which he wanted the meteorite to be known — "Luke Smith Meteorite" — and the names of the two men who chipped off souvenir pieces: "It is only fitting that such villainy be recorded in stone and put on record at our seats of learning."

As Smith continued to refuse the UWO and Toronto offers, he began to receive a barrage of criticism. One of the most virulent came from an editorial in the *St. Thomas Times Journal* in early August (quoted in *Chatham Daily News,* August 4, 1939): "How far would the world progress if Louis Pasteur had refused to reveal his amazing discoveries until a handsome price had been made? How much money did Thomas Edison demand before telling the world of his achievements? These men are the type who place progress before purses and the little Chatham dentist, while scarcely able to win a place in history with a piece of rock, could at least aid the efforts of astronomers if he would develop a little of the character of these famous men."

Smith seemed unperturbed by this blistering attack. Arguing (*Chatham Daily News,* August 5, 1939) that "the law of supply and demand holds good even for meteorites," he was content to wait out offers he claimed had been made by a number of U.S. and Canadian universities and museums, including the Smithsonian Institution, until he got the price he wanted, which he said was between $800 and $1000.

In early October, it was announced (*London Free Press,* Oct. 7, 1939) that the meteorite had "been purchased outright and now is in the possession of the University of Western Ontario." Although the price was not given, the newspaper article read "The purchase of the famous fireball was made possible through the kind offices of the directors of the London Life Insurance Company."

Through the efforts of Don Spanner, the London Life Archivist, I have found out that its Board of Directors contributed $700 to UWO to buy the meteorite from Smith. London Life's gift was motivated in large part by E.E. Reid, Managing Director, who was also a member of the University's Board of Governors. Reid stipulated he wanted the meteorite displayed in the new observatory soon to be erected on the UWO campus, a gift from the estate of Hume Cronyn. In 1970 the meteorite was moved from the Observatory (a plaster cast of it remained there), and placed in a glass showcase outside the office of the Department of Geology.

First Field Search

Once I decided to organize a search effort for more fragments of the Dresden (Ontario) meteorite, I realized this would not be a simple task. Where exactly was Dan Solomon's farm? None of the numerous newspaper articles dealing with the meteorite story gave its precise location. Nor was information provided about the exact locations of his neighbours who found — or were rumoured to have found — meteorite fragments on their farms. So my first step was to obtain a Dresden phone book, and call all the Solomons, Cummings, Lozons, Scotts, and Highgates in it. Although none of my initial efforts with the latter group paid off, I hit paydirt with the very first Solomon I tried — Betty Solomon, who turned out to be Dan's granddaughter — and quickly arranged to visit her at her Dresden home.

I also thought that the best chance of turning up new meteorite fragments would be by utilizing farmers in the area; I would inform them what a meteorite looked like and ask them if they had ever plowed up any rocks resembling one. Fellow MIAC members Peter Brown of UWO and Graham Wilson of Turnstone Geological Services, Ltd., quickly and eagerly agreed to join me in this adventure, as did Peter Jedicke, a Fanshawe College professor and President of the Royal Astronomical Society of Canada. Together, the four of us constituted what would become the first Dresden meteorite field-search team.

On July 4, 2003 I made the first of over a dozen trips to Dresden. I had a wonderful talk with Betty, who expressed great interest in my adventure but didn't know the exact location of her grandfather's farm. When I suggested that her father might well know and perhaps I could talk with him, she said she was reluctant for me to do so since this was such a painful part of family history. We then drove out to the place corresponding to Peter Millman's published coordinates of the fall (42° 31.2´ N, 82° 15.6´ W; Millman, 1940), which I had plotted on a topographical map to get a feel for the land there. Millman's coordinates, as I later found out, were about one km to the southwest of the actual fall site. Betty agreed to ask her father if he would meet with me at some time and that she and I would meet again later.

I had brought about 40 flyers with me that day that said a group of researchers was interested in the possibility of recovering more fragments of the meteorite, gave a description of what the fragments might look like, and gave my contact information. Anticipating (hoping) that this might lead to a positive response, we stated in the flyer that our search team would be in the area on the weekend of July 26-27, and that we would be happy to examine any rocks brought to us. I had planned to distribute the flyers in local stores in Dresden and the surrounding area, but realized I couldn't possibly accomplish that in the remaining portion of the day.

So I hit upon another approach. I went to the six local newspapers in the Dresden area and asked their editors if they would publish my flyer. Their responses were uniformly enthusiastic, way beyond my expectations, and each was happy not only to publish the flyer but also run a story about the meteorite and our new search.

A week later, on July 11, I made another trip to Dresden and spoke to as many of the local farmers there that I could. A few long-time residents remembered where Solomon's farm had been located, and informed me who now owned that property. When I met him, the new owner showed me the place of the meteorite's fall (Fig. 1b) and gave me a few contact names.

When I returned to London, a pleasant surprise awaited me — a message on my answering machine from Devon Elliott, saying "I believe I have a fragment of the Dresden meteorite...." Since he lived in London, I asked him if he could bring it to my office for examination. When he did, I saw immediately that the 156.65-g specimen he brought in (Fig. 4) was a genuine meteorite. According to Devon, his grandfather, Murray McKim, the owner of a Dresden electrical-appliance store, was about eight years old when he saw the meteor flash across the sky and crash not far from where he lived near the Solomon farm. He hopped on his bike, rode over to the site, and dug the fragment out of the ground. I was thrilled to turn up a hitherto unknown fragment of the meteorite. The Dresden meteorite search team was off to a good start!

Figure 4 – Devon Elliott on the campus of the University of Western Ontario holds the 156.65-g fragment of the meteorite that had been found by his grandfather, Murray McKim. Photo by the author.

Soon thereafter, people began contacting me at UWO. Two dozen Dresden-area persons either phoned or emailed, saying they had rocks they'd like checked to see if they were meteorites. I made a plan to set up an examination table outside the Dresden Tim Hortons restaurant where they could bring their rocks on the weekend of July 26-27, and arranged a meeting schedule. A few London-area persons brought rocks directly to my office for me to examine prior to the Dresden search, but, with the exception of Devon's, none were meteorites.

On July 26-27, the team moved into high gear. The first thing we did was to revisit the site of the original fall to take an accurate GPS reading (42° 31.47´ N, 82° 14.53´ W). The landowner then showed us a box full of rocks gathered near the site that he thought might be meteorite fragments, but they all turned out to be slag. Graham and I set up our examination table (Fig. 5) and inspected 26 rocks that weekend, including those on farms we visited where the rocks were too large for transport. Again there was a great deal of slag, but no meteorites. As we did this, the two Peters travelled the adjoining concession

Figure 5 – Graham Wilson (seated) examines one of the "meteorwrongs" brought to the examination table that was set up outside the Tim Hortons restaurant during the first field search. Photo by the author.

roads, talking to farmers and distributing an additional 60 flyers.

Two leads looked especially promising, and we excitedly pursued them. One, from the sister of the man who married one of Luke Smith's five daughters, was a box of rocks cleaned out of Smith's garage following his death. A quick look showed that none were meteorites. The most promising lead, from the same individual, was supposedly a piece of the meteorite that Smith had broken off and given to this daughter as a wedding present. This turned out to be yet another piece of slag. I also found time during this busy weekend to talk with Wilfred Solomon, Betty's gentle, soft-spoken father, who provided me with a great deal of valuable information. Even though our

Figure 6 – The 251.7-g Cumming fragment, the first fragment of the meteorite recovered, was found with the help of the family dog, Shep (diameter of the coin is 23 mm). This broken individual, reportedly once twice its present size, is currently in the possession of the author. Photo by Graham Wilson.

search team didn't manage to turn up any new meteorite specimens that weekend, we considered it a productive outing.

In the days and weeks that followed, I pursued the search from as many different angles as I could. I went back to Dresden several more times, talked to as many farmers as possible, distributed an additional 150 flyers in the area (Fig. 1b), looked up local history in the Dresden and Chatham public libraries, and phoned, and phoned, and phoned possible leads. From this, I was able to locate the Cumming fragment (Fig.6), now weighing 251.7 g, in the possession of Bruce's son Hugh. I was also able to determine the location of the Lozon, Scott, and Highgate farms, and thus map out the rather small strewnfield of the meteorite's fall (Fig. 1b). Although I was later able to locate the Lozon fragment (Fig. 7), I could not do so with the Scott or Highgate fragments.

Figure 7 – The 1885-g Lozon fragment is the largest individual piece of the meteorite after the main mass. It is currently in the Canadian National Collection of Meteorites, Geological Survey of Canada, Ottawa, Ontario. Photo by Richard Herd.

UWO Tribute to Dan Solomon

My talks with Betty and Wilfred Solomon made me realize the extent to which Dan's quick sale of the meteorite and its subsequent sale for 175 times the amount was, quite understandably, such a painful part of their family history. I also realized that UWO had never acknowledged Dan's role in recovering the meteorite, or the role it played as a research tool and stimulus at the university. I strongly felt that something should be done about that. In conjunction with Wayne Nesbitt, the Chair of UWO's Department of Earth Sciences, I arranged for the university to hold a dinner on campus to pay a long-overdue tribute to Dan and the Dresden meteorite and to invite as many Solomon family members as could attend.

On November 3, 2003 thirty-three members of the Solomon family — three generations of Dan's descendants — and twelve members of the UWO community and its guests convened at the university to attend "The Dresden (Ontario) Meteorite: A Tribute to Dan Solomon." After viewing the main mass of the meteorite in its display case outside the office of the Department of Earth Sciences, family members were given a brief tour of the Department's research facilities, and then went to the dinner and tribute (Fig. 8).

Before dinner, I welcomed everyone, spoke briefly about Dan's kind, gentle character and how highly he was regarded in the Dresden community, and the role he had played in the recovery of the meteorite. I also told how from a very early date the meteorite had provided science students and a few interested faculty members at UWO with an invaluable source of hands-on material for them to learn about the science of meteorites. As a result, the study of meteorites is now a significant part of the research of several university professors and is an essential component of the university's recently established Planetary Science Program.

Figure 8 – Thirty-three members of the Solomon family - three generations of Dan Solomon's descendants - convened at the University of Western Ontario to attend "The Dresden (Ontario) Meteorite: A Tribute to Dan Solomon." Photo by Alan Noon.

I saved the best for last — two total surprises for the Solomons. The first surprise was that they were presented with a small individual specimen of the Dresden (Ontario) meteorite. This specimen, a ~57-g individual (Fig. 9), had been purchased by David Gregory, a St. Thomas physician and meteorite enthusiast/collector. When David told me he generously wished to donate it to me to aid in our search effort, I suggested it would be more meaningful to give it to the Solomons as a tangible keepsake of a very important chapter in their family history. He readily agreed.

The second surprise was that they were informed a student award was being established at the university in their family's name. Acting on a great suggestion by Wayne Nesbitt, I helped solicit funds from the university to support the award. Beginning in the 2005-06 academic year, a $500 "Solomon Family Award in Planetary Science" will be awarded to a second-year student in the Honours Specialization Program in Planetary Science, based on academic achievement and financial need. "The Dresden (Ontario) Meteorite: A Tribute to Dan Solomon" thus turned out to be not only a happy occasion, but also one of deep and long-lasting significance for the Solomon family.

Second Field Search

In my continuing talks with Dresden-area farmers, one in particular sounded very promising. His farm was located between the original Solomon farm and the Cumming and Lozon farms (Fig. 1b); he told me of memories he had as a child of throwing all the rocks his father unearthed into the drainage ditch that ran alongside the property to see how large a splash they could make. This intrigued me, because this area is almost completely devoid of rocks. I had noticed this when I went driving around looking for piles accumulated by farmers as they discarded rocks they had plowed up — a common enough sight on most farms — except there weren't any. Talks with area farmers confirmed the near-complete absence of rocks. I asked him if he had any memory of what the rocks he tossed into the ditch looked like, and he said he had a vague recollection of them being black with small indentations! When I told him they might well have been fragments of the meteorite, he replied he had thought so at the time but hadn't cared.

On hearing this I immediately began to wonder how I could best act on this startling information. He told me that the drainage ditch had been dredged a few years ago, and that its top layer of dirt and debris had been thrown a few metres away along its entire 1.2 km length. I asked for permission to conduct

Figure 9 –The ~57-g Grand Bend fragment that was presented to the Solomon family at the University's tribute to Dan Solomon. Originally bought at a Grand Bend flea market, the fragment was subsequently purchased by David Gregory, who donated it to the University of Western Ontario. Photo by David Gregory.

Figure 10 – Three of Dan Solomon's children were able to attend the University's tribute: Wilfred Solomon (seated left) holds a framed stamp memento celebrating the University's 125th anniversary of its founding, Gertrude Simmons (seated right) holds the fragment of the meteorite that was presented to the family, and Clifford Solomon (standing centre) looks on. In the back row (left to right) are Howard Plotkin; Nils Petersen, the University's Vice-President (Research); Fred Longstaffe, Dean of the Faculty of Science; Kathleen Okruhlik, Dean of the Faculty of Arts and Humanities; and David Gregory. Photo by Alan Noon.

a search along the ditch, and he readily agreed and offered his hearty encouragement.

The second field search was carried out May 1-2, 2004. The four members of the first search team were joined in this effort by MIAC Associate Members Margaret Campbell-Brown, Phil McCausland, and Paul Wiegert, as well as by Devon Elliott, UWO colleague Roberta Flemming, and David Gregory. We divided into five two-person groups, each group equipped with a metal detector and a shovel. On the first day we explored (Fig. 11) the area adjacent to the drainage ditch along the northeast side of the farm as best we could (part of it had already been planted in wheat, which we didn't want to trample), and a small, heavily wooded area behind the original Highgate farm (Fig. 1b) that had never been farmed.

Figure 11 – Five members of the second field search team are shown here: in the foreground (left to right) Peter Jedicke, Graham Wilson, and David Gregory prepare to dig at the site of an iron-detector "hit," while in the background (left to right) Peter Brown and Margaret Campbell-Brown pause awaiting the result. Part of the northeast-bounding drainage ditch can be seen at the left. Photo by the author.

At the end of a long day of searching, which netted us various scraps of metal but no meteorites, we met with Hugh Cumming and weighed and photographed his specimen. On the second day, in a freezing rainstorm, a reduced search team (Phil, Paul, Devon, Roberta, and I) spent the morning exploring the area adjacent to a shorter ditch alongside a concession road abutting the northwest side of the farm (Fig. 1b). Over a hot lunch at a Dresden restaurant, while we dried off and warmed up, we reluctantly decided to call an end to the search, as our metal detectors were so wet they were not functioning well; at that point, neither were we. We evaluated what we had — and had not — accomplished over the weekend and pondered the advisability of doing another search at some future time, especially the area alongside the drainage ditch that was then planted in wheat.

Conclusion

Through archival research, several visits to the Dresden area, talks with area farmers, talks with Betty and Wilfred Solomon, two field searches, and numerous phone calls to follow up all the leads, I was able to locate the precise location of the fall of the main mass, as well as the locations of places where smaller fragments had been found. In this way, I was able to map out the known strewnfield (Fig. 1b). These efforts also led to knowledge of the present location of the Lozon fragment and some previously unknown fragments, most notably the sawn slab in the Royal Ontario Museum and the recovery of the Cumming, McKim, and Grand Bend fragments.

As rewarding as all of this was, the best part of the entire experience for me was the human one. With but a single exception, everyone I spoke with in the Dresden area was warm, courteous, and friendly, and eager to help out in any way possible. Above all else, my contacts with Betty and Wilfred Solomon, with their quiet dignity and intense family pride, touched me deeply and enriched me immeasurably. The story of the Dresden meteorite is, at heart, a Solomon family story, and I dedicate this paper to them.

Postscript

On October 8, 2005 a third and final field search was carried out to explore the last remaining stretch of land adjacent to the drainage ditch along the northeast side of the farm (Fig. 1b). Devon Elliott and I were joined in this search by Stanley Wortner, a local amateur archaeologist who had observed the Dresden fireball as a youth. Once again, however, although our metal detectors found lots of scrap metal, they failed to uncover any meteorite fragments. Now that local farmers are aware of the story, perhaps someday someone will rediscover a piece that has been lying forgotten in their basement or attic or retrieve a newly plowed-up fragment. If so, the next chapter can be added to the fascinating story of the Dresden meteorite.

Appendix

The following listing of all known (and suspected) fragments of the Dresden meteorite is given in order of decreasing size. The fragments are referred to either by descriptive names used in this paper or their present location, and I have provided some salient details about their acquisition history where available.

1. Main mass. A 40.07-kg H6 ordinary chondrite, recovered by Dan Solomon on July 12, 1939. Acquired by the University of Western Ontario through a $700 donation from the London Life Insurance Company. Gifted to the University on October 6, 1939. I thank Don Spanner, the Archivist at London Life, for providing helpful information.

2. Lozon fragment. A 1885-g complete individual, recovered by Henry Lozon on July 12, 1939, now in the Canadian National Collection of Meteorites, Geological Survey of Canada (GSC), Ottawa, Ontario. Although the record of its acquisition is a bit sketchy, it appears to have been sold to the GSC by Louise Harrison, Lozon's widow, sometime after 1977. The GSC also holds fragments of 25.4g and 3.36g, as well as a 9.52-g polished section and a 1.52-g thin section. I thank Richard Herd, the Curator of National Collections at the GSC, for providing helpful information.

3. Royal Ontario Museum (ROM), Toronto, Ontario, specimen. A 1814-g sawn slab from the main mass, given to the ROM on March 27, 1943 by G.H. Reavely, Department of Geology, UWO. I thank Katherine Dunnell of the ROM's Department of Earth Sciences and Graham Wilson for providing helpful information about this specimen, which surprisingly is not listed in the latest (fifth) edition of the *Catalogue of Meteorites* (Grady, 2000).

4. McKay fragment. Reported to have once been 1.5 lbs (681 g), this fragment was supposedly taken from the main mass on July 12, 1939 prior to the meteorite's removal from the Solomon farm. It was cut in half by UWO's G.H. Reaveley in accordance with McKay's instructions, with half returned to him and half kept by UWO (*London Free Press,* August 10, 1939). I have been unable to locate either of these halves.

5. David Dunlap Observatory fragment. According to one report (Anon., 1943), a 13-oz. (~ 370-g) fragment from the main mass is in the Observatory's holdings, along with an "excellent" tinted cast of the meteorite.

6. Cumming fragment. The first recovered specimen of the meteorite, retrieved by Bruce Cumming with the aid of his dog Shep on July 11, 1939. Currently 251.7 g, this broken individual supposedly was twice as large before various persons broke off pieces from it. It is currently in the possession of the author.

7. McKim fragment. A 156.65-g individual supposedly retrieved by Murray McKim on July 11, 1939 somewhere near the Solomon farm. It later passed to his grandson Devon Elliott and is currently in his possession.

8. Scott fragment. Numerous phone discussions with A.V. Scott's descendants have failed to locate the fragment's location, though several persons remember having seen it at one time or another.

9. Highgate fragment. Here, too, I have been unable to locate this fragment — if, in fact, it exists at all. Acting on solid information that such a fragment existed, a member of the GSC attempted to approach Arnettie Highgate, George's widow, about it in November 1966, but she "did not answer the door." In my discussions with her daughter, she insisted that no member of the family had ever owned a fragment of the meteorite.

10. Grand Bend fragment. This ~57-g broken individual was purchased by David Gregory from a person who had bought it at a Grand Bend flea market. Gregory generously donated this specimen to UWO, and it was given to members of the Solomon family at the University's tribute to Dan Solomon on November 3, 2003. Although there once were accompanying papers giving the concession and lot number where the meteorite was found, they unfortunately cannot be located now.

11. Smithsonian Institution specimen. The National Collection of meteorites at the Smithsonian's National Museum of Natural History contains a 27.8-g slice. The Museum's Accession Records do not shed light on where it was found originally. The National Collection also has a very small cut fragment and polished thin section, together weighing 0.14 g, obtained from J. DuPont. I thank Linda Welzenbach, the Collections Manager of the National Collection, for providing helpful information.

12. *Toronto Star* fragment. According to a report by Pleva and Colgrove (1939), a Mr. Carty, a reporter for the Toronto Star, possessed a fragment of the meteorite. No information was provided as to its size or weight. It is possible that this fragment was removed from the main mass during the time the meteorite was on display in the Toronto Daily Star building

13. DuPont fragment. According to the fifth edition of the *Catalogue of Meteorites* (Grady, 2000; p. 177), a 3.4-g fragment is currently in the DuPont Collection, Palatine, Illinois.

14. Kent County Museum fragment. A small 4.5-g chip off the Grand Bend fragment is being donated to this Chatham Museum by David Gregory.

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Bibliography

Anon. 1939, "The Dresden Meteorite," *The Sky,* 3 (no. 12), 27

Anon. 1943, "The Dresden Meteorite," *American Astronomical Society Publications,* 10 (no. 7), 387

Colgrove, W.G. 1939, "The Dresden Meteorite," *Journal of the Royal Astronomical Society of Canada,* 33, 301-303

Grady, M. 2000, *Catalogue of Meteorites. With Special Reference to Those Represented in the Collection of the Natural History Museum, London,* fifth ed. (Cambridge Univ. Press: Cambridge)

Millman, P. 1940, "The Dresden Meteorite," *American Astronomical Society Publications,* 10 (no. 1), 23-24

Pleva, E.G. and Colgrove, W.G. 1939, "Committee's Report on Dresden Meteorite," *Journal of the Royal Astronomical Society of Canada,* 33, 303-308

New Horizons: Mission to Pluto, Charon, and Beyond; Launch of Long-Awaited Project to Study the Outer Solar System

by Leo Enright, Kingston Centre (tcorbor@frontenac.net)

As I sit down to write this article, it is now exactly 22 minutes after the launch of man's first spacecraft designed to study the planet Pluto and its satellite Charon; 22 minutes since the launch of the first robotic mission to study the denizens at the very edge of the Solar System.

For four decades, since the very beginning of the exploration of the Moon and the Solar System, there has been a great desire to learn more about what was once called the Ninth Planet, but what is now sometimes called "the King of the TNOs" - the Trans-Neptunian Objects that populate the Kuiper Belt well beyond the orbit of the planet Neptune. The culmination of those dreams is the scientific probe, known as *New Horizons* that shot up into the sky over Cape Canaveral in Florida today, January 19, 2006. It is a truly amazing feat of technology and one that has been in the planning stages for over 15 years.

This craft is about the size of a grand piano and is loaded with very sophisticated and extremely-sensitive instruments. It is powered by a small amount of plutonium, since solar panels at the distance of Pluto and beyond would not be able to generate sufficient energy even for this small spacecraft to operate. It has instruments to look for magnetic fields and to measure the speed of escape of particles from Pluto's very thin atmosphere. Another instrument will use radio waves to analyze the atmosphere and to measure Pluto's night-side temperature. Yet another will use ultraviolet light to determine the precise composition of the atmosphere — probably composed largely of nitrogen, carbon monoxide, and methane, although these gases likely freeze to the surface when Pluto is near aphelion. Another important device will use infrared measurements to determine surface composition and to make colour maps of the surfaces of both Pluto and Charon. A very-high-resolution telescope and camera will be capable of detecting surface features as small as a football field. Another instrument, being put into operation for the first time on a spacecraft, will count and measure dust particles in space throughout the very long journey.

A long journey it is indeed, but this craft is going to be travelling very, very fast. As I write these words, now over 50 minutes since the launch, the craft is already a considerable distance on its way to the Moon, which it will pass later today, in fact in about 8 hours from now. (Remember the *Apollo* spacecraft that took astronauts to the Moon in 1969, a destination they reached in three days?) In March 2007 *New Horizons* will pass Jupiter and receive a gravity assist as it emerges from the region of "the Giant of the Planets," a sling-shot effect that will push its velocity up over 75,000 kilometres per hour. Finally, in July 2015, about nine years from now, it will reach the first of its destinations and begin the study of Pluto from a distance of only 10,000 km above the surface; that is, from a distance 40 times closer than is the Moon from the Earth's surface. We will probably be inundated with information at that time, in a manner similar to what happened in the 1980s with the flood of new information and stunning images during the *Pioneer* flyby of Saturn and later of Uranus and Neptune. It is just possible that we may also learn more about Pluto's second and third moons, discovered just three months ago. (Yes, Charon is not the sole moon of Pluto. Yes, Pluto has more moons than planet Earth or planet Mars!)

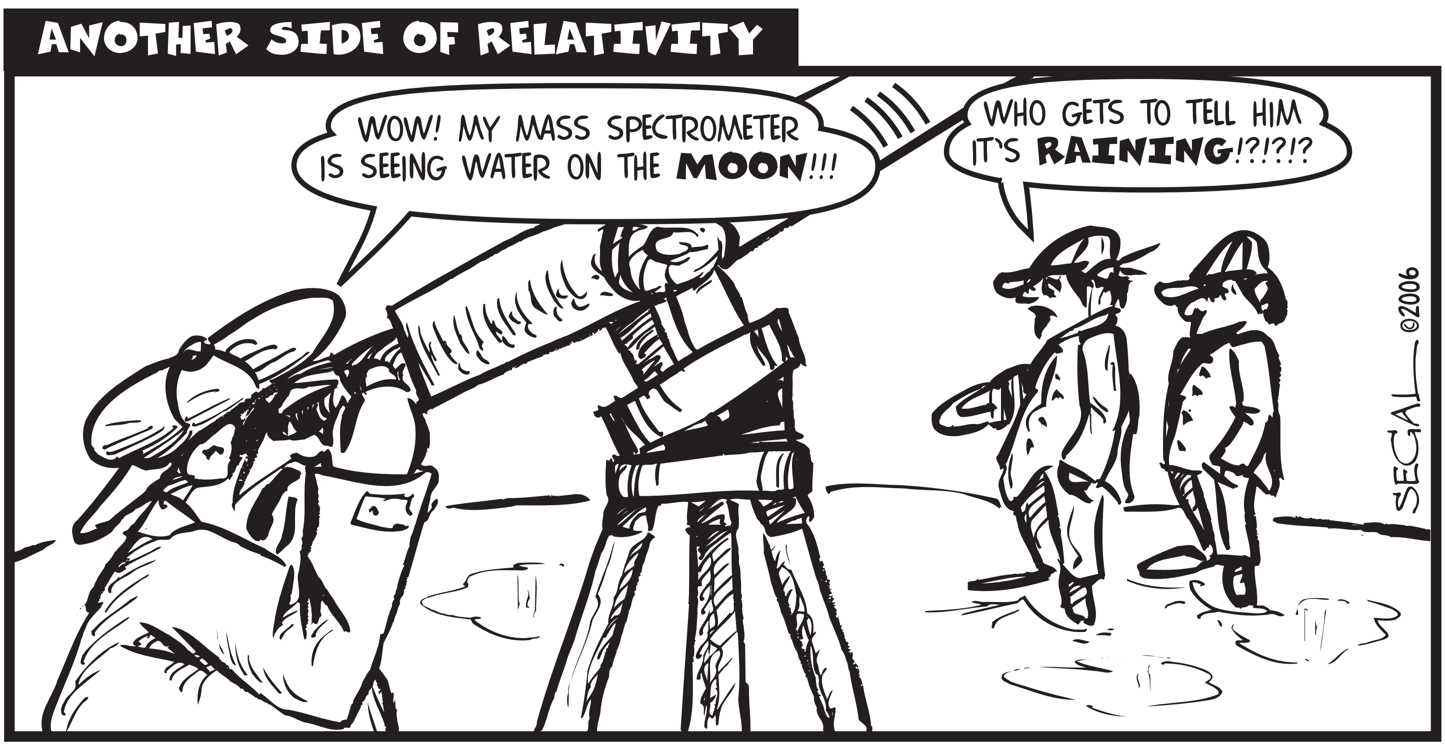
After that, it is onward to the Kuiper Belt, a vast, disk-shaped cloud of thousands upon thousands of solid icy bodies extending out to over seven-billion kilometres from the Sun. The Belt is named for Gerard Kuiper, an astronomer who, in the 1950s, predicted their existence, though none of the objects had then been discovered. By now we have photographed well over 100 of them and will likely eventually have names for many more of the thousands that surely exist in the deep freeze at the edge of the Solar System. In fact, just last summer astronomers found a TNO named 2003 UB313 that is slightly larger than Pluto. Learning more about these objects is far more important than it may seem to some people, since TNOs are believed to have remained as they were at the beginning of the Solar System, and can provide a frozen record of conditions from the time of formation of our Sun and planets.

Today's launch of *New Horizons* is one that I will surely remember for a couple of reasons other than for its importance as a scientific venture. Just as many others did, I was able to watch the countdown on television on the NASA channel. (Probably many RASC members did exactly the same thing!) However, being a snowbird and finding myself at a location about 400 kilometres from the launch site, I was prepared, one minute after the launch, with binoculars and camera, to view the speeding spacecraft rising high above Cape Canaveral. Regrettably, clouds above my northeastern horizon prevented any such view, although on previous launches from the Cape it had been possible to see the spacecraft for a short while. The other memorable aspect of this event is the fact that my Centre's Honorary President, David Levy, the official biographer of Clyde Tombaugh, Pluto's discoverer, had come to Florida for the launch of the "Mission To Pluto," and I had a chance to have a couple of phone conversations with him. We made plans to visit but because the launch was twice postponed, the planned visit also had to be delayed. Nonetheless, it was good to know that David did have the opportunity to see the launch of the "Mission to Pluto and the Kuiper Belt."

David and I both know that if Clyde Tombaugh were still alive, he would have been very excited about what happened just a short while ago. In fact, very appropriately, a few of Clyde's ashes are being carried to the outer edge of the solar system aboard the *New Horizons* spacecraft. I remember years ago when we were so very fortunate to have Clyde, the discoverer of "the last major planet," speak to the members of the Kingston Centre after sharing dinner. That night, while talking about one of his favorite topics, he said, in the unique and wonderful way he filled his speech with some of the best (and worst) puns in the English language, "I am a Plutocrat!" On a day like today, as we await the scientific revelations we expect in July 2015 and beyond, how could any of us not wish also to say, "We look forward to being Plutocrats."?

Bon voyage, *New Horizons!*

Leo Enright, longtime member of the Kingston Centre, and Editor of The Beginning Observer's Guide, waxes poetic about missions to other worlds.



Researching Canada's Star Stories

Could an astronomy travel-guide create a broader interest in the night sky?

by Peter McMahon (pmcmahon@discovery.ca)

Three years ago, my girlfriend (now my wife) and I were camping in a provincial park I've enjoyed for most of my childhood. We paddled inward a few lakes to enjoy the beautiful fall colours, the lonely cry of the loon, and the crisp clear view of the night sky.

But something was different this time. I felt that evening like I had to strain more than usual to see a distant galaxy I spotted when I was 12, and the river of the Milky Way wasn't quite as wide.

It could have been that my eyesight was just a few years past its peak, or that a slight haze obscured our view that night. But there was another possibility — one I hoped was wrong: the night sky from the park was actually less visible than it was only a few years before.

Though I *fear* that our views of the night sky and our knowledge of the constellations might be on the wane, even in the wilderness, I *know* that our chances of experiencing such things anywhere near a city are dwindling each year. More and more school children I talk to at summer camps and museum star nights tell me they've *never* seen the Milky Way — having lived in urban areas all their lives — and constellations that used to sport dozens of stars from the outskirts of my hometown of 70,000 now only reveal seven or eight points of light.

That night, amongst the fresh air and pine scent of the wilderness, I wondered if there were places in Canada where we could find the stars of years gone by.

The search begins

To answer that question, I've set out to find the best spots in Canada from which to experience the night sky.

"Best" is a pretty broad term, but what I'm looking to drop into that category are places that offer the ultimate combination of dark skies and cultural significance: essentially, astronomy "destinations."

As it turns out, many of the places I've found so far are in parks and conservation areas accessible to the general public. Moreover, many of these places boast hidden treasures that are as much a celebration of the *land* as the sky above.

Though amateur astronomers might know about the Torrance Barrens "dark-sky preserve" in Ontario, you might not know about another one under consideration in Ontario's cottage country. Kawartha Highlands Park — not quite a provincial park and more than just a large chunk of Crown land — boasts some of the darkest skies you're ever likely to see so close to major urban centres. What's more, the park is minutes from

Petroglyphs Provincial Park, which boasts the largest concentration of native rock carvings (at least 900) in Canada, some of which have astronomical origins. Local native guides even surmise that one of the carvings is a likeness of the Little Dipper.

The Cypress Hills region of Saskatchewan is another area of the country known for its pristine skies and wide-open observing locations. Even further north, there's a hidden observing gem nestled in the middle of a piece of history. Two summers ago, I was in Prince Albert National Park and had just come back from a hike to the cabin of Grey Owl, the naturalist and beaver conversationalist who made the area famous. Later that night, on the shores of nearby Kingsmere Lake, I saw just why it was worth putting some distance between me and even the dimmest cottage porch lights. In addition to the clearest sky I've seen anywhere, I was treated to a view of Castor (from which the word "beaver" is derived) one of the twin stars in the constellation Gemini. I wondered if Grey Owl ever considered the patterns he saw in the night sky here above his cabin and the tangential connection one of them had to his life's work.

An outdoor enthusiast's sky guide

As I've traveled into other parts of Canada, I've met people who've told me stories about the stars above Banff and Killarney, the Maritimes, and the Rockies, written generations ago - not by the ancient Greeks or Romans - but by ancient *Canadians*.

I'm in the midst of gathering together tales and locales from my own travels and from the people who've learned of these stories and places firsthand, along with hints, tips, maps, and fun moments from the portage. I'm hoping to assemble it all into a guide to enjoying these exciting stargazing destinations — one of our country's greatest natural resources. If all goes well, I suspect they'll become an important part of our wilderness heritage and — I hope — a new reason for Canadians to enjoy our precious wild spaces.

If you have a wilderness observing location tip for Peter or would like to learn more about the locations he's cataloguing, log on to www.northstarproductions.ca.

Peter McMahon is an award-winning online science journalist. He is currently a producer for DiscoveryChannel.ca and editor of Science Link, the journal of the Canadian Science Writers' Association. His wilderness stargazing research journals are slated to appear later this year on www.science.ca.

Second Light

Exciting Times With Cosmic Rays

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

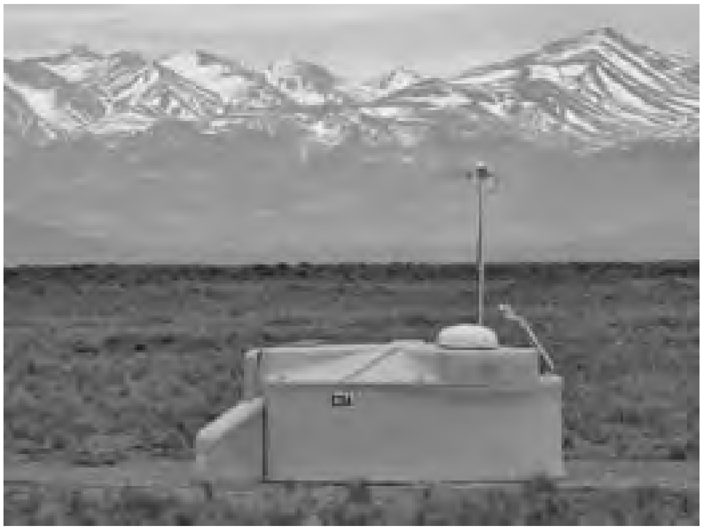
Cosmic rays are electrons, protons, and the nuclei of elements heavier than hydrogen — all the way up to lead — that are accelerated to relativistic speeds (very close to the speed of light), where the only meaningful measure is their total energy, which is usually expressed in electron volts (eV). At the highest energies, where the cosmic rays have the energy of a thrown baseball (!), the questions are how they are accelerated, and what kinds of places can accelerate them. The newly dedicated Pierre Auger Observatory, in the pampas of Mendoza province in Argentina, should answer these questions and settle a controversy that has arisen over the last three years or so (see www.auger.org).

Cosmic rays fall into, roughly, three categories. The lowest energy ones come from the Sun, where they are accelerated by magnetic fields as part of the solar wind, with a component from solar flares. They hit the ground at a rate of ~10,000 per square metre per second. The next category is named "Galactic cosmic rays" — they come from sources throughout our Milky Way galaxy, where the main contributors appear to be supernova remnants. It has been amply demonstrated that Galactic cosmic-ray electrons come from the remnants, and recently the final proof seems to have come for cosmic-ray protons (see Aharonian *et al*. in the 9 Feb issue of *Nature*). They hit the ground at a rate of about one per square metre per second.

The most exciting — and the most mysterious — cosmic rays are those with energies at or above 10^{19} eV. These arrive at a rate of about one per square kilometre per year at an energy of 10^{19} eV. For comparison, the rest-mass energy of an electron is 5.12×10^{3} eV, while the rest-mass energy of a proton is 9.38×10^{8} eV, so you can see that — unlike the case in everyday life — the total energy of the particles is completely dominated by their kinetic energy, rather than their rest-mass energy.

The origins of these highest-energy cosmic rays are still mysterious, both theoretically and observationally. None of them have been convincingly traced back to a source in the sky — though various people have attempted to correlate them with active galactic nuclei (AGN) — and on the theory side it isn't at all clear what kind of source could accelerate them. Whatever the sources are, they must be very energetic, which is why AGN seem a possibility. There is a chance that they might be accelerated in gamma-ray bursts, or perhaps they come from the decay of dark-matter particles.

But these ultra-high-energy cosmic rays introduce yet another mystery. As they travel through space they encounter photons of the cosmic microwave background. Each time they hit one of these photons, they give up about 20 percent of their energy to the photon. By the time the cosmic ray has travelled about 50 Mpc its energy will be below about 5×10^{19} eV, after which they stop interacting with the photons. As there are very few energetic AGN within 50 Mpc of our Galaxy, we should see



A view of surface detector "Ezra" on site in Argentina. One can see the battery box (left), the electronics dome (top), solar panels, and communications mast.

effectively zero cosmic rays at energies above 5×10^{19} eV, yet two well-documented events with energies $>10^{20}$ eV have been seen. One was in 1991, at the "Fly's Eye" experiment in Utah, and the second was in 1993, by the Agasa experiment in Japan. For almost ten years, the Agasa experiment has been claiming that they do not see any cut-off at 5×10^{19} eV, which prompted theoretical physicists to invent exotic explanations. Within the last two years, though, a new experiment in Utah — called HiRes — has seen the cut-off. Which experiment is right has prompted vigorous debates at conferences.

Settling this debate should be easily accomplished by the Auger Observatory. The Agasa experiment uses a different technique than HiRes, but Auger uses both to cross-calibrate. The Auger ground detectors are comprised of 1600 plastic tanks, each holding 3000 gallons of water and separated from each other by 1.5 km. When the cosmic rays enter the water they are travelling faster than the speed of light in water, and emit a characteristic blue light (Cerenkov radiation), which is tracked by detectors mounted inside the tanks. The second technique relies on the fact that the cosmic rays interact with nitrogen in Earth's atmosphere, leaving a trail of fluorescence behind them. While these trails are invisible to the human eye, Auger's telescope mirrors monitor the space over 3000 sq km of the pampas. Over half of the tanks are installed, and the last of four telescope arrays will be finished by the end of 2006.

This amazing project now has over 200 physicists from 55 institutions as collaborators, and the observatory in Argentina is only the southern half. They gathered, along with representatives of the Argentine government, the governor of Mendoza province, and the mayor of Malargüe (where the Auger headquarters is located) on November 9-11 to celebrate and dedicate the observatory. It was a fun festival of physics, punctuated by a hanging bridge over a river being swept away and a long trek across bumpy and dusty roads to the farthest reaches of the array.

A northern equivalent, to be built in southeastern Colorado, has been proposed and a decision on funding should be reached within the next year or so. Funding in the U.S. (from which about half the money will come) is tight, however. Fortunately, most of the rest of the money will come from Europe, which in recent years has generously funded scientific projects like the Very Large Telescope.

This very interesting area of physics is one where even high schools can contribute. A project named ALTA, begun in 1996 at the University of Alberta, has blossomed into a network of high schools in North America searching for ultra-high-energy cosmic rays (see `http://csr.phys.ualberta.ca/nalta`, "Crop" at `http://cse.unl.edu/~gsnow/crop/crop.html`, and Chicos at `www.chicos.Caltech.edu`). A similar project named HISPARC is now running in the Netherlands (see `www.hisparc.nl/NL/english.html`). Because the energies are so high, basic detectors can easily be fabricated and operated by high-school physics students in collaboration with a local university. The more collecting area the better, when the flux is one particle per square km per century!

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

Binoviewers

by Geoff Gaherty, Toronto Centre (ggaherty@rogers.com)

A few years ago my friend Pedro introduced me to the joys of binoviewing. He loaned me a binoviewer to try. I was hooked and immediately bought one for myself. I later upgraded to a better one, which involved a substantial outlay of cash, plus an investment in pairs of eyepieces. Now, suddenly, it seems as if every telescope company is importing binoviewers from China at a very reasonable price. What used to be a very expensive part of visual astronomy is now becoming affordable to many observers. The binoviewer (Figure 1) is appearing under brands such as Burgess, Celestron, Orion, Stellarvue, and William.

So, what is a binoviewer? It is an optical device that utilizes a beam splitter and two right-angle prisms. You insert it into your telescope's eyepiece holder, and then insert two matching eyepieces into the binoviewer. The binoviewer splits the light coming from your telescope mirror and presents a view of the scene to each eye. Although each of your eyes is seeing exactly the same image, the overall effect is much more than that. Detail that is marginal with a single eye leaps out when you use two eyes, and most people report a strong impression of a three-dimensional view. Floaters in our eyes, the scourge of us older astronomers, seem to be cancelled by our brain's visual-processing system. Most importantly, all the strain of squinting through a single eyepiece disappears, and you can enjoy a natural, relaxed, two-eyed view of the heavens.

Figure 1– Binoviewer.

What are the disadvantages of binoviewers? The main one is that they require about 10 to 13 cm of extra in-travel in the focuser to compensate for their long optical paths. They work best on scopes that focus by moving the primary mirror: *e.g.* most Schmidt-Cassegrains and Maksutov-Cassegrains. They work less well on Newtonians and refractors where, unless you are prepared to do surgery on your telescope tube, some optical trickery is required to move the telescope's focal plane farther out. Fortunately, many of the new bargain binoviewers include special transfer lenses to do just that, relying on a Barlow lens that is added between the focuser and the binoviewer. That solution brings the image to focus, but the combination of Barlow lens and long-projection distance leads to very high magnifications. That magnification may be fine for lunar and planetary observation, but will not desirable for wide-field views of deep-sky objects.

One way to reduce the magnification is to reduce the projection distance. Look around for a Barlow lens that looks like Figure 2.

Notice that the optics are contained in a black cell that screws into the chrome body of the Barlow. The thread on the cell just happens to be the same as the standard 1.25-inch filter thread, and the inexpensive binoviewers all have that thread on their entry ports. Unscrew the black cell from the Barlow, and screw it directly into the binoviewer, and you can reduce the amplification from about 4× to about 3×. These Barlows are widely available under a variety of brand names such as the Celestron Omni and the Orion Shorty. These just happen to be the two I have actually tried, but similar Barlows are widely available: the clue is the screw-on black lens cell.

A more expensive but better solution is to use a TeleVue

Figure 2 – Barlow lens. The black collar on the right side can be unscrewed and reset into a binoviewer.

2.5× Powermate. While this product functions as a Barlow in many respects, it has a special property particularly useful with a binoviewer. Increasing the projection distance has the effect of slightly *reducing* the magnification factor, so the 2.5× Powermate actually produces about 2.2× magnification. Unfortunately the Powermate costs almost as much as the binoviewer, though the combination is still much cheaper than any previous binoviewer.

How do these new inexpensive binoviewers compare with the high-end models? Pretty well, except that they have a somewhat narrower clear aperture because of the smaller prisms used. That factor puts a limit on the usable field of view — wide-angle eyepieces probably will show vignetting.

Although the idea of buying pairs of eyepieces is daunting, because of the long effective focal ratios you can get away with less-expensive eyepieces. I have found that ordinary Plössls and orthoscopics work very well. Because of the high-amplification factors with Newtonians and refractors, you are most likely to be working with eyepieces in the 25-mm to 15-mm range. Most of us have at least one eyepiece in that range, so you only need to locate its twin; however, it is important that the second eyepiece be as identical as possible, since any mismatch of eyepieces will lead to a mismatch of the views presented to each eye.

A fair number of people find that they have difficulty merging the images in a binoviewer, so it is wise to try before you buy. Fortunately binoviewers work very well for most people, and add a spectacular enhancement to observing, especially of the Moon and planets.

Pairs of galaxies

I said before that I am a sucker for action. I am also a sucker for pairs of objects, particularly galaxies. I still remember vividly my first view of the galaxies M81 and M82 in Ursa Major on April 12, 1959. I had already observed a dozen galaxies through my 20-cm Newtonian but, to my inexperienced eyes they all looked pretty much alike, except for the gigantic Andromeda Galaxy. M81 and M82, however, really looked *different* through the telescope: M81, smooth, bright, and oval; M82, obviously spindle-shaped and strangely mottled.

There are several well-known pairs of galaxies in Alan Dyer's Finest NGC list. Probably my favourite is NGC 4038 and 4039 in Corvus: two edge-on galaxies in contact forming a perfect little V shape. These are known as the "Antennae" or the "Ring-Tail Galaxy." Others include the "Eyes," NGC 4435 and 4438, and the "Siamese Twins," NGC 4567 and 4568, all four in Virgo.

As I have been working my way through the Herschel 400 list, I have discovered more pairs of my own. NGC 4485 and 4490 in Canes Venatici I nicknamed "mother and daughter" and NGC 3226 and 3227 in Leo I named "mama bear and baby bear." NGC 3166 and 3169 in Sextans are an easy starhop just south of Regulus. It is not just galaxies that come in pairs. NGC 6522 and 6528 are a neat pair of globular clusters in Sagittarius, and NGC 6755 and 6756 are a nice pair of open clusters in Aquila.

For a double-double treat, take a look at some of these deep-sky pairs with a binoviewer!

Geoff Gaherty was very active in the Montreal Centre back in the'50s and '60s until he got a life. After thirty years he returned to the astronomical fold, this time with the Toronto Centre. At an age when most people are retiring, he's suddenly become gainfully employed as an astronomer, working for the Royal Ontario Museum and Starry Night Software.

The Skies Over Canada
Observing Committee News

by Christopher Fleming, London Centre (chrisfleming2@hotmail.com)

Keeping a record of your astronomical observations, in the form of observing notes or drawings, has always been an important way to learn more about the night sky, and it is still true today. By looking for interesting detail to write about in the astronomical objects you observe, you will almost certainly begin to see additional detail you had never noticed before. This is especially true when making drawings, even if you have no experience in artwork. The vital thing to keep in mind is not how well you can transfer what you see to paper, but how much more detail you have been able to discern through greater scrutiny. There are guidebooks available, and resources on the Internet, that you can utilize to learn astronomical drawing skills. The difference in the quality of one drawing from the next is often in the technique used and not in the natural skill of the artist.

Many observers who have completed the Messier list comment that they did not spend enough time seeking out the finer details of each Messier object. This is understandable because a great deal of importance is placed on the skill of locating the Messier objects, for the first time, without assistance. In other words, the thrill of the hunt and the reward of finding the target can become the main focus and not necessarily the detailed study of each Messier object. All is not lost though, because the Messier objects are long-time features of the night sky and can be re-observed with an emphasis on exploring their finer details. If you have completed the Messier list and are looking for a new project, you should consider reviewing the Messier list by drawing or imaging each object, or by writing detailed observing notes that describe everything you can see.

Studying the current scientific knowledge about astronomical objects can also enhance the quality of your observing experience. This can be done before, during, or after an observing session. If you are organized enough to plan in advance the objects you intend to observe on the next clear night, then it can be very beneficial to do some research on the scientific aspects of those targets. Many popular astronomy books and magazines contain information about the age, distance, actual size, mass, and special properties or features of a wide variety of astronomical objects. This can be a valuable resource, especially when you are presenting public-star nights and curious people ask specific questions. It will also impress your friends at a dark-sky site when you not only show them an amazing deep-sky object, but also explain to them with confidence the scientific aspects of it.

The Explore the Universe Certificate Program (available in PDF format in the Observing Certificates area of the RASC Web site at `www.rasc.ca/observing`) provides new observers with a complete introduction to the night sky, including Constellations and Bright Stars, the Moon, the Solar System, Deep-Sky Objects, Double Stars, and an optional Variable-Star List. There is also a list of optional observations in the Solar-System portion that, when combined with the rest of the program, provides the new observer with a complete overview of all the popular observing categories available. While these optional observations are not mandatory in order to receive the certificate, they do encourage observers to explore a variety of objects, or events, that are often more spectacular, but occur less frequently. It also lists some coveted observations that are more challenging such as finding Pluto through a telescope. Some observers have told us that they plan to observe all 110 observations listed in the Explore the Universe program, plus the optional Solar System observations, and the optional variable-star list, before seeking their Explore the Universe Certificate. That is an honourable goal and best of luck to them, although the optional list was mainly intended as a part of a life list of things to do as the opportunities present themselves.

The complete optional list of Solar-System observations or events includes: Pluto, lunar eclipses, solar eclipses, conjunctions, meteor showers, aurorae, comets, asteroids, and the zodiacal light. There are of course several more specialized observing goals that could be included on such a list, but we felt that those were the most common for a typical astronomy enthusiast. In the next article we will delve into the details of the optional variable-star list.

There have been two Explore the Universe Certificates awarded since our last report and those talented observers are listed in Table 1.

There was only one Messier Certificate awarded since our

Table 1: Explore the Universe Certificate Recipients		
Name	**Centre**	**Date Awarded**
Brian Hollander	Kitchener-Waterloo, Ont.	December 2005
Maryanne Weiler	Kitchener-Waterloo, Ont.	December 2005

Table 2: Messier Certificate Recipient		
Name	**Centre**	**Date Awarded**
Les Dempsey	Belleville, Ontario	February 2006

Table 3: Finest NGC Certificate Recipient		
Name	**Centre**	**Date Awarded**
Ray Drouillard	Windsor, Ontario	December 2005

last report, but this flagship program has seen more certificates awarded in the past four years than at any other time in its history. The highest year-to-date total was in 2003 when 26 Messier Certificates were awarded, while the past four-year total, from 2002-2005, is 79. The Observing Committee is thrilled with those numbers and we encourage RASC members to keep up the good work! The latest recipient of a Messier Certificate is listed in Table 2.

There was also one Finest NGC Certificate awarded since our last report, and since it was received before the end of 2005 it has been included for that year's total. As I reported in the last issue, the 2005 total of ten awarded as of the end of November tied the record for most in a year. Well, this additional Finest NGC Certificate awarded in December brings the final total to 11 for 2005, a new record for one year! It is great to see such active participation in our observing-certificate programs and we congratulate all those observers who have successfully completed one or more of these programs over the years. The latest FNGC recipient is listed in Table 3 and Ray is also recognized as the first observer to send in a complete record of his observations, and drawings, using the new deluxe observing forms available for download on the Finest NGC Web page. Nice work Ray and way-to-go!

Congratulations to all!

The Observing Committee continues to update the observing sections that have been posted on the RASC Web site over the last few years at: `www.rasc.ca/observing/sections.html`. There you will find information about asteroids, comets, variable stars, and special projects. Finder charts are posted for asteroids that are currently brighter than magnitude 10, and during May and June 2006 you will be able to print charts for (1) Ceres, (2) Pallas, (6) Hebe, (8) Flora, (10) Hygiea, (15) Eunomia, (29) Amphitrite, and (532) Herculina. The Variable-Stars Section features links to genuine AAVSO (American Association of Variable Star Observers) magnitude-estimate charts and during May and June 2006 you will be able to print charts for the long-period variables T Cassiopeiae, U Ceti, T Camelopardalis, R Leporis, R Lyncis, R Corvi, S Ursae Majoris, R Bootis, R Draconis, T Herculis, RT Cygni, RU Cygni, and S Pegasi. Each of those LPV stars will reach a maximum of magnitude 8 or brighter during that time. In addition, the Variable-Stars Section features links to charts for many other interesting variable stars.

The Comets Section provided charts for the Comet C/2005 E2 McNaught during the winter months and will continue to post charts for comets that are bright enough to observe visually through telescopes. The Special-Projects Section continues to be upgraded with additional links to Web sites of interest across Canada. This upgrade has been a gradual one, as time permits, and we thank those who have sent in URLs to their Web sites. All of those links will be posted eventually and we appreciate your patience until that process is complete.

Clear Skies!

Christopher Fleming is Chair of the RASC Observing Committee and Observers' Chair in the London Centre. He enjoys all types of observing, especially Deep-sky, Lunar, Double Stars, and Variable Stars. Chris is also a musician and Webmaster of the London Jazz Society's Web site.

Deep-Sky Contemplations

by Warren Finlay (warren.finlay@interbaun.com) and Doug Hube (jdhube@telus.net)

The proverbial "faint fuzzies" are often little more than that when close to the limit of detection with a given instrument. In reality, of course, every object, whether faint or bright, fuzzy or replete with fine structure, has its own set of physical characteristics that are the product of its particular mass, age, composition, dynamical state, and neighbourhood, even if we can't always observe these characteristics in the eyepiece. To that list can be added observer-dependent characteristics that include orientation to the line-of-sight, something that can be seen in the eyepiece.

When observing near the limits of one's visual acuity and instrumental capabilities, the special features of an object may only become apparent when comparison is made nearly simultaneously with a neighbouring object having different properties. This month we present two objects that are comparable in apparent brightness, located at the same distance, but that differ at a fundamental level as well as in orientation.

NGC 4036 and NGC 4041 are galaxies located within the boundaries of the great concentration of galaxies in Ursa Major, but in a "gap" that makes finding and identifying them unambiguous and easier than might otherwise be the case. With apparent visual magnitudes 10.7 and 11.3, respectively, and dimensions 4.0′ × 1.8′ and 2.7′ × 2′, they cover comparable areas on the sky and have, on average, similar surface brightness. The apparent dimensions do indicate, however, that one is observed more-or-less edge-on and the other face-on.

NGC 4036 is a nearly edge-on lenticular galaxy. That is, a galaxy with the profile of a spiral but lacking a disk that is sharply distinguished from the nuclear region. In a lenticular galaxy the nuclear bulge blends smoothly into a flatter disk-like region that, unlike a normal spiral is deficient (usually) in interstellar gas and dust. Whereas a dark band of dust may bisect an edge-on spiral, that feature is absent (usually) in a lenticular. One explanation for lenticulars is that they long ago consumed their interstellar matter and are no longer forming new stars. The

Figure 2 – 50′ × 50′ field that includes NGC 4036 and NGC 4041 taken from POSS images.

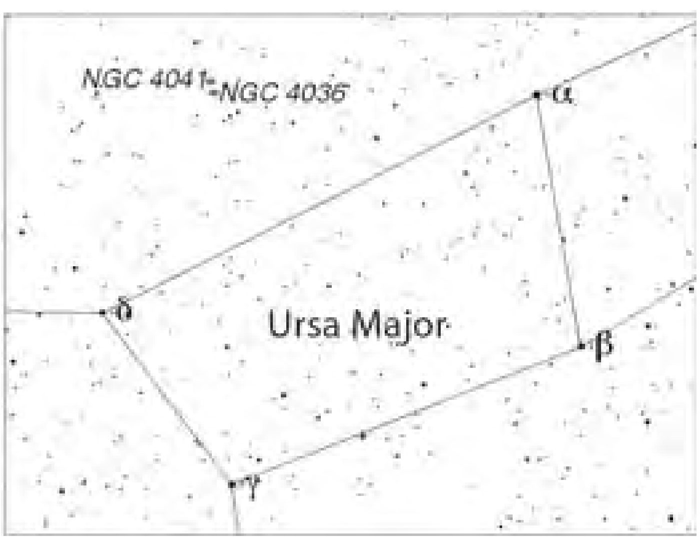


Figure 1 – Field within Ursa Major containing NGC 4036 and NGC 4041.

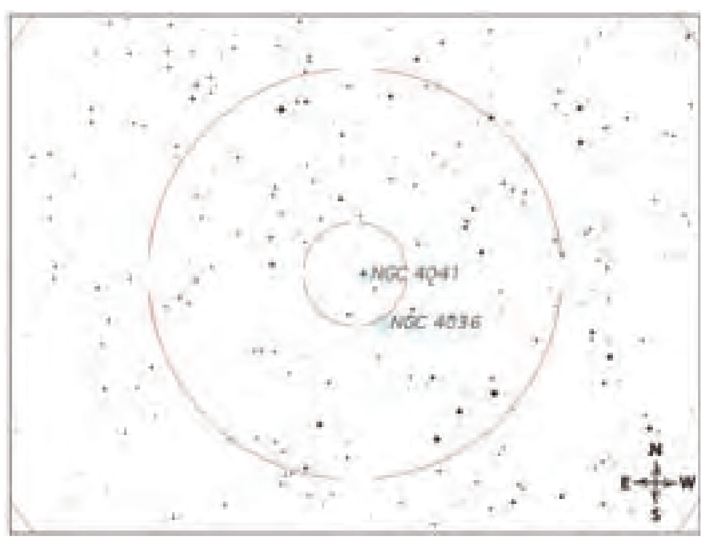


Figure 3 – Finder chart shown with 0.5° and 2° Telrad circles (and part of 4° circle).

"usually" used above is indicative of the fact that the morphological classification of some lenticulars can be difficult: some galaxies so classified do have bands of interstellar dust; others have been classified as ellipticals. One of the best known examples of a lenticular galaxy is M86, which, however, is not viewed edge-on as is NGC 4036.

NGC 4036 is a somewhat unusual lenticular because its inner few arc seconds contain ionized hydrogen gas whose origins are not well understood. The luminous mass of the galaxy is about 150 billion Suns. In a 12.5-inch telescope it appears obviously lens-shaped with a bright core and no other visible structure, fading off into nothing in all directions.

In contrast to NGC 4036, NGC 4041 is a nearly face-on spiral galaxy. Spiral arms replete with nebulae and concentrations of young stars wind loosely around a distinct nucleus. Even if the nucleus can be detected with your telescope, the surrounding lower-surface-brightness disk may remain a challenge. Indeed, in a typical amateur telescope, if you didn't know better you might mistake this galaxy as a dim, unresolved globular cluster. NGC 4041 is thought to harbour a central black hole with a mass of several million Suns. At a distance of approximately 80 million light years, the expansion of our Universe causes this galaxy to move away from us by about an Earth diameter in the time it takes to read this sentence.

NGC 4036 [RA(2000) = 12^h 1.5^m, DEC(2000) = +61° 54′] and NGC 4041 [12^h 2.2^m , +62° 08′] are located "above" the bowl of the Big Dipper. NGC 4036 is a half degree northeast of a pair of 6.5-magnitude stars. NGC 4041 is another 15′ northeast of NGC 4036, a physical distance of about 300,000 light years.

These two galaxies are not just visual companions in the sky: they are part of a gravitationally bound group of galaxies, doing an orbital dance over the ages that even Tolkien's Ents would find slow moving.

Warren Finlay is the author of "Concise Catalog of Deep-sky Objects: Astrophysical Information for 500 Galaxies, Clusters and Nebulae" (Springer, 2003) and has been enamoured with the deep sky for over 30 years. Doug Hube is a professional astronomer retired from the University of Alberta.

Gizmos

Finding Up

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

Before they will tell you which way to look, GOTO telescopes want you to tell them which way is up. For that you need an accurate level. This is more difficult than you might think because often even high-end levels don't read true when you buy them, and the cheaper ones are dreadful.

I prefer a circular bull's-eye level because when you use it on a tripod you can see at a glance which legs to adjust. The little units you see in hardware stores seldom read true and are too small to be used this way, but mounted on an aluminum disk and made adjustable, they become a dandy tripod level that can be very accurate.

I used a three inch disk cut from 3/16″ aluminum with a hole saw, but you can make a disk from aluminum with almost any saw that cuts wood. Insert a bolt through the centre so that you can spin it in a drill. With a file and some sandpaper (to the edges only, not the face) you can make a nicely finished product.

You will need a bull's-eye level with a flange and mounting holes, not the glue-on kind. Lay out the three holes with care, dimple the points with a center punch or an awl, and drill with a 3/32″ bit. Cut the thread with a 4-36 taper tap (similar to a bolt, but with cutting edges) and a tap wrench, both available in any well-stocked hardware store. Put a drop of oil on the tap and wind it into the hole. When it begins to bite, back up a quarter turn to clear the chips. Advance a half turn, back a quarter turn and so on. Don't force it or the tap will break. If it doesn't go easily, advance less and back more.

The completed tripod level.

True up the face of the disk by stroking it on a sheet of 220-grit sandpaper taped to a piece of plate glass. Don't overdo this. You need only remove the burrs and high points left by cutting and tapping.

Assemble your level as shown, with three 4-36 round-head bolts and three 1/8″ × 1/4″ rubber O-rings. The O-rings are the secret. Because they compress, you can tighten the bolts to varying degrees and thus adjust your level. The procedure is easy. You do not need another level or even a level surface.

Use a flat surface like a kitchen counter. Tape down some stops (two rulers?) at right angles and position your level into the corner. Looking straight down on it, rotate your level slowly. If the bubble rotates with the level and transcribes a circle over the counter, slightly tighten the bolt on the side to which the bubble gets closest during a full rotation. Keep doing this until the bubble remains exactly stationary relative to the counter while you turn. If at this point the bubble is not quite centred in the circle it means that your counter isn't level.

You now have a very accurate tripod level. When next you set up your tripod, put the level on the flat top and retract the leg to which the bubble points. With practice, only two legs will need adjustment and your scope will be ready to roll.

Don Van Akker makes his living digging holes and putting buildings in them. He observes from the rain coast with his wife Elizabeth so he has many free evenings to work on these ideas.

Ramblings of a Variable-Star Addict

The Wonderful World of Easy Eclipsers

by Richard Huziak, Saskatoon Centre (huziak@sedsystems.ca)

With the exception of the Sun, Moon, planets, and occasional meteors, comets, and aurorae, the rest of the sky often appears quite static. The Messier objects look just about the same as they did when Messier discovered them (with the exception of M1, which has dimmed through expansion). The vast majority of sky objects don't change in our lifetime, so I always get a thrill when I find a new object in the sky that actually changes as I watch it over my observing session. Jupiter observers know what I mean — *the Dance of the Moons is* fascinating, and changes can be seen in as little as a few minutes. This is also true of a large number of variable stars.

As promised in the previous *Journal* the first variable star I will introduce to you is RZ Cassiopeiae or RZ Cas for short. RZ Cas was the first variable star that I observed way back in 1976. My source of inspiration was none other than the incomparable *Burnham's Celestial Handbook*. If you haven't looked at your *Burnham's* lately, pull it off the shelf, blow the dust off, and turn to pages 501-502.

Significant change in brightness can occur in just a few minutes for eclipsing binary stars and RZ Cas is likely the best eclipser to demonstrate that for every starwatcher with binoculars or a spotting scope. It is quite bright, with a magnitude range of 6.4v to 7.8v. When the star eclipses, it fades quickly. You don't have to wait very long for the next eclipse - a mere 1 day, 4 hours, and 41 minutes, and 10.4 seconds (1.1952598d). RZ Cas has a good sequence of comparison stars against which to make brightness estimates. The star is circumpolar for Canadians. This star also presents some interesting surprises now and then.

RZ Cas is an eclipsing binary of type EA/SD. In easy speak, this equates to an eclipsing binary of the Algol type (EA), semi-detached (SD). There are a few different types of binary stars we'll get into sooner or later, but each eclipsing binary will look a bit different depending on how *attached* the stars are. In the case of RZ Cas the two stars revolve fairly closely together and partially eclipse each other twice on every orbital revolution. For visual observers, only the *primary eclipse,* or the deepest eclipse, is detectable. *Semi-detached* means the stars are far enough away from each other that they cannot be accused of inappropriate touching, but close enough that the stars can exchange gas, which I'll elaborate on later. The "detachedness" of the stars allows the light curve to be flat in between eclipses. For eclipsers of the Algol class the magnitude of the system will remain at a steady brightness with otherwise fairly featureless light curves when they not scheduled to be eclipsing. Eclipsing binaries are technically *extrinsic* variables, where the light changes due to the simple geometry of eclipses and not due to

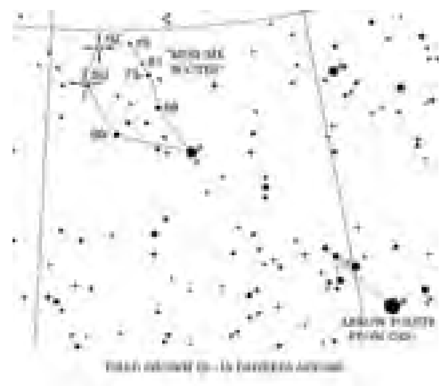


Figure 1 – Finder chart for RZ Cas. This is a portion of the AAVSO chart, used with permission.

physical changes to the star's surface or energy output, however, as you will find later, a slight reclassification of this star is necessary since it doesn't follow simple EA rules.

So much for the technical bits right now. How do you observe this star, and why would you want to in the first place? You can use the chart in *Burnham's,* or better yet, download the RZ Cas chart from the AAVSO Web site. To find RZ Cas I use my binoculars and follow a line joining the two left-most stars of Cassiopeia's W (δ & ε) and extend that line to the left until I hit ι Cas. The region of ε Cas looks like an arrowhead pointing in the direction you need to head. ι then becomes *Arcturus* for a little asterism to the upper left that looks an awful lot like Boötes. One of the upper stars in this *Mini-me Boötes* is RZ Cas.

The first time you find RZ Cas you will have about a 15% chance of catching it in eclipse. Because its period is basically one and one-sixth days, all you have to do is look at the field at the same time for each of six consecutive nights. It will have to be in eclipse on one of those nights. A much easier way is to find an ephemeride that will predict the next eclipse for you. Three very good sources for eclipser ephemerides are given in the *Internet Resources* for this article.

With the AAVSO or *Burnham's* chart and the prediction in hand, you'll want to make your first observation about 1.5 hours before the scheduled eclipse time. First identify RZ Cas and study the field, finding appropriate comparison stars. When you are comfortable, make an estimate to one-tenth of a magnitude by interpolating a best-guess brightness between the two comparison stars. If the brightness is within a few tenths of a magnitude of 6.4, the star is likely not in eclipse or just may be beginning one.

An observation made and not recorded is a lost and forgotten observation, so take time to record the date and time of this observation to the nearest minute, the estimated magnitude of the star, the pre-determined values of the comparisons stars, and the chart you used. A typical variable-star observation looks something like this in my book:

Star: RZ Cas
Time of observation: June 12, 2005, 9:36pm CST
Estimated Mag: 6.5
Comparison stars used: 6.0 & 6.6
Chart used - AAVSO dated 1/01.

Now that you've started, you will want to make another estimate every 10 or 15 minutes, recording the new value of RZ Cas as the star begins to fade along with the new comparison stars used. RZ Cas is a pretty fast-moving star as eclipsers go. As time progresses, the star will fade down to around 7.8 magnitude, then will take the next 1.5 hours to recover back to its out-of-eclipse brightness. Even if you cannot catch the entire eclipse during your observing session, watch a part of the eclipse and enjoy the fading or recovery of the star! This is Newtonian motion in action with *real change* in the sky!

Even the laziest of us can observe and enjoy the eclipses of RZ Cas. When something really exciting is on TV, like *Stampede Wrestling* or *Three's Company* reruns, I have been known to observe eclipses of RZ Cas during commercial breaks. I take the first minute of the break to rush outside and get dark adapted, and the second minute to make my estimate. The result is an instant light curve and I didn't even miss a line from Chrissy, Janet, or Jack's script!

Studying the chart further, you may already have noticed that there is a second variable star in the field (which is not marked in *Burnham's*). The bright star to the lower left of RZ Cas is SU Cas. SU Cas is a Cepheid variable that takes 1.949319 days to complete its pulsation cycle between magnitudes 5.7v and 6.2v, so you might as well make an estimate of this star and record it also. One or two estimates of SU Cas per night are adequate, since its light changes more slowly.

If you get enough data points, you can plot a light-curve graph by plotting magnitude on the Y-axis and time on the X-axis. If you did a decent job of estimating your light curve might look somewhat like one of my curves illustrated here. If your light curve doesn't resemble mine, don't sweat it. With some practice and time your light curves and estimating ability will improve. Then again, maybe RZ Cas is throwing *you* a curve!

So why do we care about eclipsing binaries at all? Besides seeing Newton's Laws in action, semi-detached and attached eclipsing binaries are really exciting in different ways. As it turns out, the RZ Cas system is a very interesting and very rare type of EA, recently better classified as an EA/DSCT system. RZ Cas is one of only 13 EA stars known to contain a δ-Scuti (δSct) type variable as one of the components. δSct variables pulsate rapidly. The primary star of RZ Cas pulsates in a period of only 22 minutes and has an amplitude of 0.015 magnitudes. This is the shortest period of any known δSct star. It is also known that the secondary star is inflated beyond its Roche limit and is spilling gas onto the δSct primary star. Recent studies indicate that the gas stream impacts directly onto the primary star, creating a hot spot that emits X-rays. This implies the primary star has a strong magnetic field and may be gravitationally locked with the same side always facing the larger secondary, however this most-current interpretation of the physical characteristics of the system cannot explain many aspects of the light curve.

The light curve of RZ Cas is unusual in many aspects since it does not repeat perfectly every eclipse. The system is usually classified as a partial-eclipsing system, where the brighter primary is not completely covered by the secondary star and the light curve begins to recover immediately after the minimum light has been reached (Figure 2). However many eclipses have been reported where the light curve remains flat-bottomed for a while, indicating that the eclipse is total (Figure 3). Furthermore, some eclipses show marked asymmetry in the falling and rising branches (Figure 4), and some also show flat stalls in the curve, particularly on the rising branch. All of these effects cannot easily be explained by a gas stream that hits the star directly,

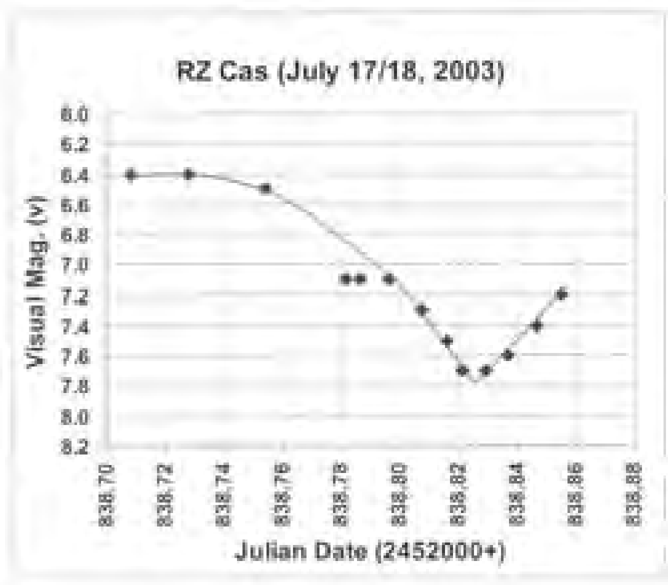


Figure 2 – A "normal" primary eclipse for RZ Cas, whatever that means! The symmetrical fading and immediate recovery of the light curve indicates a partial eclipse. Discordant points may be poor estimates or less likely may indicate a step on the descending curve. Solid curves have been hand-drawn. All three light curves are reproduced at the same scale.

but are better explained by the presence of an accretion disk around the star that periodically changes in size, inflating and deflating with changes in gas flow.

This star has been studied many times by professional astronomers with dozens of papers written about or referencing RZ Cas, but despite this the exact physics of the system remains a mystery. One of the downfalls for professionals studying this system is that scorchingly bright RZ Cas at 6.4 magnitude makes it hard to study. Stars as bright as 6.4 saturate all but small CCD-

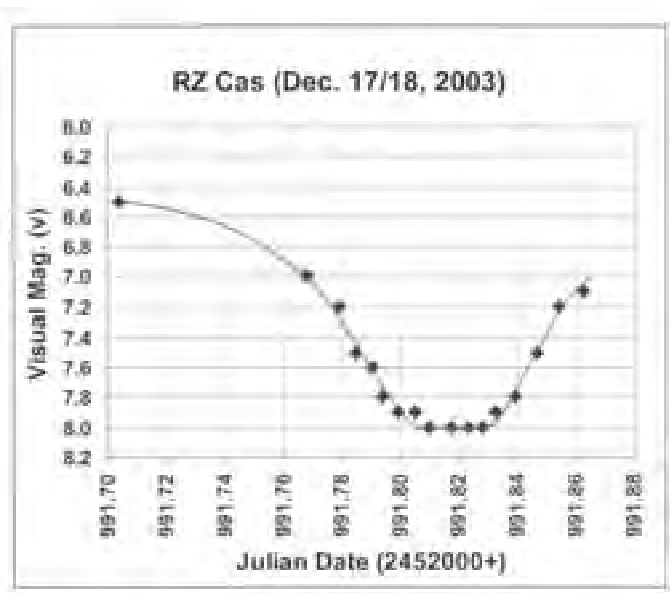


Figure 3 – This RZ Cas light curve shows what appears to be a total eclipse. The curve is flat-bottomed for over half hour before beginning its recovery to maximum light.

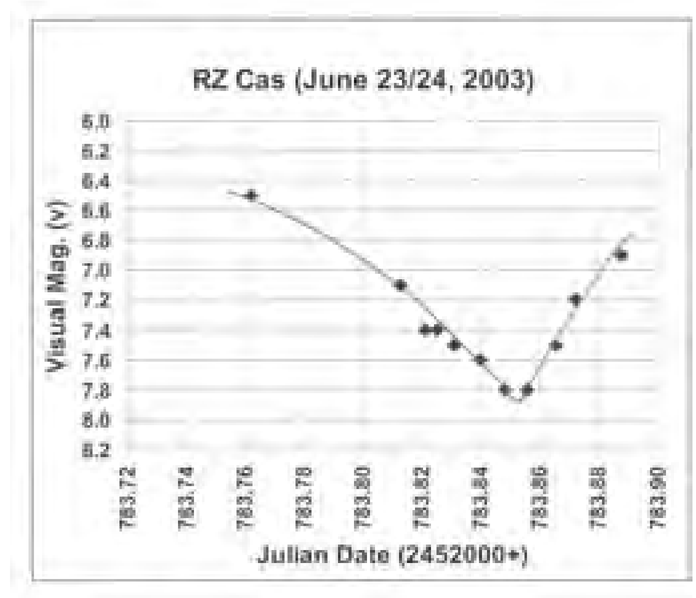


Figure 4 – RZ Cas sometimes shows an asymmetrical light curve where the ascending and descending branches have different slopes.

based telescopes. As a result, this system offers itself to amateur astronomers who can easily make observations of the shape of the primary eclipse visually using binoculars, or with CCD cameras using telephoto lenses. My dream would be for amateurs to catch every observable eclipse of this star, and with almost 5000 RASC members, this would not be a difficult task. If we were successful in this, we might be able to watch the system's changing eclipses form and unform, and maybe we could help to solve this mystery.

Someone out there is always hoping to use a record of tonight's observations for education, a science project, or for genuine research and publication. In every article, past, present, and future, I will reiterate — *report your observations!* It is easy to do using the AAVSO's reporting tools found on their Web site.

References

Burnham, R. 1975, *Burnham's Celestial Handbook,* 501-502

Rodriguez et al. 2004, *Monthly Notices of the Royal Astronomical Society,* **347,** 1317

Eclipses for RZ Cas Visible in Canada, April/May 2006

Date	Time (UT)*	Date	Time (UT)*
Apr. 3-4	4.5	Apr. 27-28	2.5
Apr. 4-5	9.5	Apr. 28-29	7.0
Apr. 9-10	4.0	May 4-5	6.5
Apr. 10-11	9.0	May 10-11	6.0
Apr. 15-16	3.5	May 16-17	5.5
Apr. 16-17	8.0	May 22-23	5.0
Apr. 21-22	3.0	May 29-30	9.0
Apr. 22-23	7.5		

* Note: Many eclipse predictions are given only to the nearest half hour as not to bias observers' calculations of "Times of Minimum."

Internet Resources for Eclipsing Variable Stars

Charts & General Information:

AAVSO Web site and go to the charts subdirectory:
`www.aavso.org`
Bob Nelson's eclipser site - tons of research on eclipsers:
`www.aavso.org/observing/programs/eclipser/omc/nelson_omc.shtml`
RASC Variable-Star Observing page:
`www.rasc.ca/observing/variablestars/index.html`

Ephemerides for eclipsers:

AAVSO Eclipsing Binary Ephemerides:
`www.aavso.org/observing/programs/eclipser/eb2006.pdf`
Shawn Dvorak's Web site to find EBs for the night:
`www.rollinghillsobs.org:8000/perl/calcEBephem.pl`
Mt. Suhora Observatory eclipse predictions:
`www.as.ap.krakow.pl/ephem`

Rick Huziak, Past-President of the Saskatoon Centre, Chair of the Saskatchewan Light-Pollution Committee, and enthusiastic observer, loves to write about his favourite subject — variable stars.

TIMINGS WANTED!

If anyone wants a variable-star project, the following AAVSO Algol-type stars do not have recent timings of minima, so no one is really sure if these stars are eclipsing on time or not. A great many Algol-type stars change their periods through mass-exchange processes. Mass exchange changes the centre-of-mass of the system, and so the revolution period changes in response. It is important to observe these stars to determine a new ephemeris for each. For visual observing make sure your watch is set to the nearest minute. This is astrophysics in action, folks! Why not watch the sky change in real time? Ephemerides, possibly inaccurate, for these stars can be found at:

`www.aavso.org/observing/programs/eb/ebephem.shtml`

Times of minimum will be given to the nearest half hour assuming the older predictions are accurate. I would suggest that you begin observing as soon as it gets dark that evening and observe the star every 15 minutes (visual) or as often as possible. Report your observations using UT time to the AAVSO database and do *not* convert to heliocentric time before reporting. (More on this, another day). This is a worthy program for all apertures and moonlit conditions. Charts for these stars are available on-line at:

`www.aavso.org/observing/charts`

Just type the name of each star in the "NAME" box, and stand back!

Name	Range	Period (d)	Last Observed Min.
AC Tau	10.3 - 13.1V	2.043356	1988
RW Cap	9.8 - 11.0p	3.392446	1996
TW And	8.8 - 10.9V	4.122774	1997
AQ Peg	10.4 - 12.7V	5.5485028	1999
AG Vir	8.5 - 9.1V	0.64265075	2000
δ Lib	4.9 - 5.9V	2.3273543	2000
RV Per	10.3 - 12.7V	1.9734926	2000
SW Cyg	9.3 - 12.0V	4.57313411	2000
XZ Aql	10.1 - 11.4p	2.139181	2000
AL Cam	10.5 - 11.3p	1.32833335	2001
BO Mon	10.0 - 12.1V	2.2252193	2001
EW Lyr	11.2 - 13.5V	1.948723	2001
SS Cet	9.4 - 13.0V	2.973976	2001
Y Cam	10.6 - 12.0V	3.3056244	2001
Y Leo	10.1 - 13.2V	1.6861020	2001
ZZ Boo	6.8 - 7.4V	4.9917440	2001
AM Tau	10.4 - 12.3V	2.043926	2002
CT Her	10.6 - 11.7p	1.7863748	2002
FL Lyr	9.3 - 9.9V	2.1781544	2002
RV Tri	11.5 - 13.3p	0.75366648	2002
RW Tau	8.0 - 11.6V	2.7688356	2002
RY Aqr	8.8 - 10.1V	1.966594	2002
SX Oph	11.8 - 12.3p	2.0633038	2002
FZ Del	10.2 - 11.3p	0.7832126	2002
TT Del	10.6 - 12.5p	2.871119	2002
TY Del	9.7 - 10.9V	1.19112689	2002
UZ Dra	9.9 - 10.7p	3.2613024	2002
V343 Aql	10.6 - 12.3p	1.844603	2002
V346 Cyg	11.8 - 13.5p	2.743282	2002
W Del	9.7 - 12.3V	4.806100	2002
WW Cyg	10.0 - 13.3V	3.3177690	2002

Mercurial Meandering

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

there was light and then there was darkness.
and there was no line in between.

— Ani diFranco, *Fierce Flawless*

Mercury, the innermost planet, is elusive as quicksilver, emerging but occasionally in the half-light between day and night. Known since antiquity, it has been observed (or should I say "identified") by relatively few people, but is a rewarding if underrated target for the planetary observer.

The first challenge is simply to find the darn thing. Forever bound to the vicinity of the Sun, Mercury flits back and forth from evening to morning twilight; in fact the Greeks called it Apollo at dawn and Mercury at dusk, apparently not making the connection that they were one and the same object (Price, 2000). In modern times we have a better handle on the tiny planet's erratic behaviour, not to mention such aids as astronomical almanacs, planetarium programs, and binoculars at our disposal.

I have been following the erratic wanderer for many years, but a first sighting in any apparition never fails to please. Even when I am specifically looking for my old friend, it nonetheless seems surprising to spot a bright twinkling "star" in the gloaming.

Most years there are six observing windows when Mercury is sufficiently to one side of the Sun that it can be seen: three in the morning and three in the evening. These apparitions are brief, a few weeks at best, with Mercury always fairly close to the horizon in the brightest area of twilight.

To further complicate the matter, the Winged Messenger is the most eccentric of the eight fully accredited planets. Its orbital eccentricity of 0.206 causes it to range from 46 to 70 million km from the Sun. From Earth's perspective, it can vary from 18 to 28 degrees from the Sun when at greatest elongation. Mercury's orbit also has a relatively steep inclination of 7° to the ecliptic, which contributes to the seemingly erratic nature of its apparitions.

By and large the orbital geometry is unfavourable to northern-hemisphere observers. Like Venus and the crescent Moon, Mercury is best seen when the ecliptic makes the steepest angle to the horizon, in the evening sky near the vernal equinox, or the morning sky around the autumnal equinox. Elongations at such times, however, occur near Mercury's perihelion, when it is less than 20° from the Sun and moving at its greatest velocity, making the apparitions relatively brief. The news is not all bad: while perihelic elongation occurs in brighter twilight, Mercury is itself in much more intense sunlight and therefore significantly brighter; its surface brightness ranges by a factor of 2.3, almost one full magnitude.

Yet another wild card is that Mercury's phase changes rapidly. As it approaches Earth during an evening apparition it grows in apparent diameter, but this is more than offset by the diminishing phase, which actually causes Mercury to fade as it approaches. So it is most easily seen in the week or so before maximum elongation. In a morning apparition this effect is reversed with Mercury brightening as it recedes.

The rate of change of Mercury's apparent brightness is very different from one apparition to the next, depending on whether the above two effects are additive or subtractive. Compare the upcoming two evening elongations, as calculated by *Guide 7.0:*

2006	
May 31	−0.9
Jun 10	−0.1
Jun 20 e	**+0.5**
Jun 30	+1.4
Sep 27	−0.2
Oct 07	−0.1
Oct 17 e	**0.0**
Oct 27	+0.4

The mean synodic period of Mercury is a shade under 116 days; however, the value of an individual such period can vary significantly above or below that mean. (See the figures.)

Telescopically, Mercury presents some interesting challenges as well. Its tiny disc displays phases, colour, and occasional dusky markings, especially near the terminator. Last summer I had frequent occasion to observe it in broad daylight, an approach I highly recommend. That method was used by earlier (and rather better-known) observers of the innermost planet, namely Giovanni Schiaparelli and E.M. Antoniadi, who preferred the view when Mercury was high in the sky and its contrast glare against the background sky greatly reduced. (Muirden, 1983)

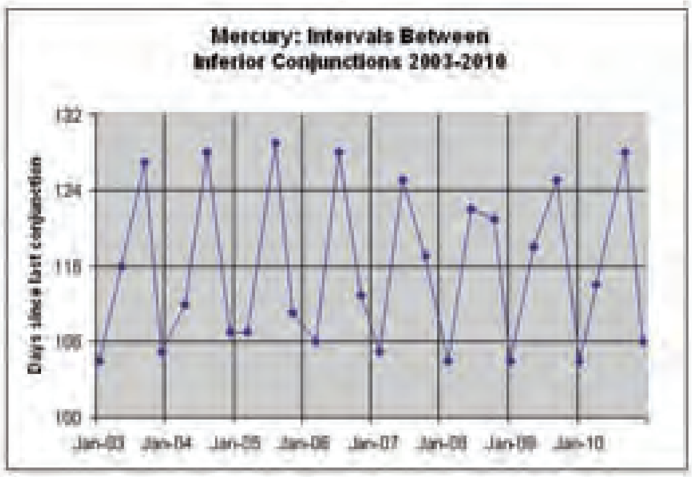


Figure 1 – The Mercury-Earth synodic period can be measured against four points: inferior conjunction (shown here), superior conjunction, eastern elongation, and western elongation. Mercury's orbital period is 88 days, however it takes it about another third of a revolution to catch up with Earth. Depending on *which* third that is and whether it contains Mercury's perihelion or aphelion, Mercury can overtake Earth more or less rapidly than the mean synodic period of 116 days. The theoretical peaks and valleys of the various cycles are (virtually) fixed to specific dates when the orbits of the two are optimally aligned. When an actual alignment takes place near that date, a data point can be seen at that peak; when the alignment is "off beat" a more moderate double peak can be seen. There are 3.15 synodic periods per year, meaning that observing seasons gradually move forward by about two and a half weeks per year, completing a full cycle in about seven years. Note how there are three inferior conjunctions in most years, but four in 2003 and 2010; note too how the shape of the curve is very similar in those two years.

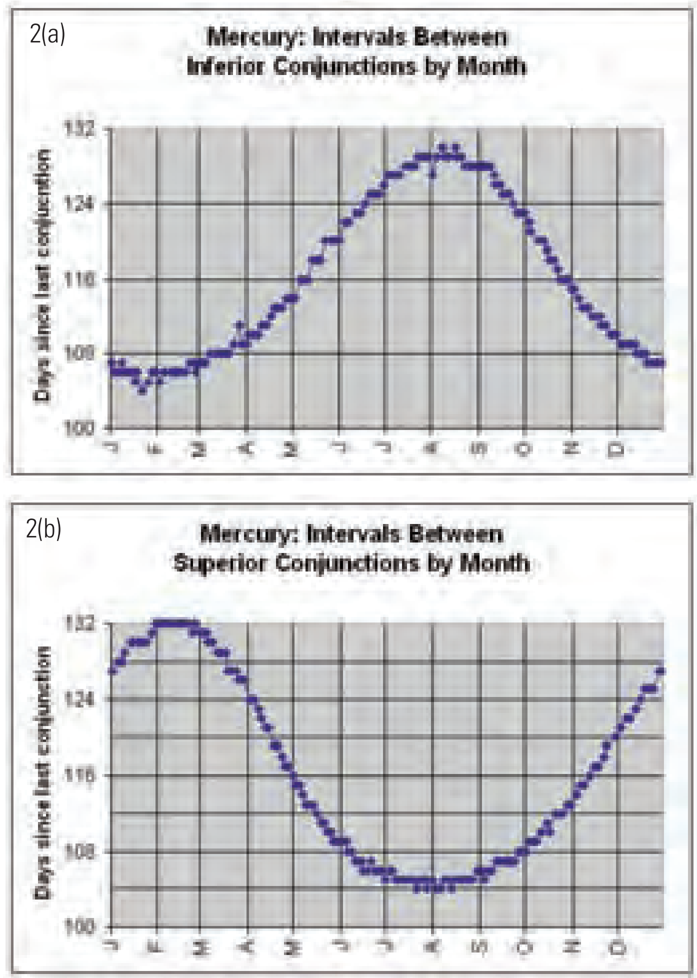


Figure 2 – All inferior and superior conjunctions of Mercury between 1976 and 2020 are plotted according to calendar date (all data courtesy Meeus 1983, 1995), measuring the interval that has passed since the previous such conjunction. Because they involve the one-dimensional alignment of the same bodies in reverse order, the resultant curves are virtual mirror images. An inferior conjunction with Mercury at perihelion (77° longitude) would occur around December 8, however since we are mapping the interval from one inferior conjunction to the next, the minimum period occurs between two events straddling that point, with the second of these occurring around the end of January, nicely matching the valley in Fig 2a. A superior conjunction on the same date would occur on the opposite side of Mercury's orbit, at aphelion, resulting in the peak seen in Fig 2b. The curves don't exhibit true mirror symmetry: the range of intervals between superior conjunctions (104-132 days) is slightly greater than that between inferior conjunctions (~105-130 days) due to Earth's own modestly eccentric orbit and its orientation with respect to Mercury.

With practice one can acquire the knack of sweeping up the tiny, shiny planet against a clear blue sky with any decent scope. With any optical instrument, one needs to guard against the Sun, ideally by placing the scope itself in a shaded spot where the target area of sky is accessible. These days my preferred method is to employ the Edmonton Centre's 16-inch Meade LX200 GPS unit, which is installed at the observatory at Telus World of Science — Edmonton. Never let it be said that a GOTO scope is without its uses! Ours is a temperamental beast that sometimes needs to be tricked into doing what the lowly human wants, but on its good days can sweep up stars and planets out of the blue at the push of a couple of buttons.

One such day was last June 27, when Mercury and Venus had an extremely close conjunction separated by less than five arcminutes. (McCurdy, 2005) Through broken cloud I took advantage of the rare opportunity to observe and compare Earth's inferior neighbours in the same high-power field of view. At 1.53 AU from Earth, Venus was beyond the Sun; Mercury "beside" it at 1.02 AU. Both were gibbous with a hard round edge on the sunward side, but Venus was 91% illuminated, Mercury only 61%. In addition to its lower phase angle, Mercury is smaller with a lower albedo, so despite being closer than Venus to both Earth and Sun it appeared four full magnitudes dimmer. Its disc appeared a pale peach colour compared to the pure white of Venus.

Even at their closest point until 2070, the two planets were separated by some 30 Venus diameters, underscoring how truly rare is an occultation of one planet by another. In fact, only one such event has ever been observed telescopically, and by a single observer at that. It happened to involve the same pair of planets, as the English amateur John Bevis observed the occultation of Mercury by Venus through similarly broken cloud from Royal

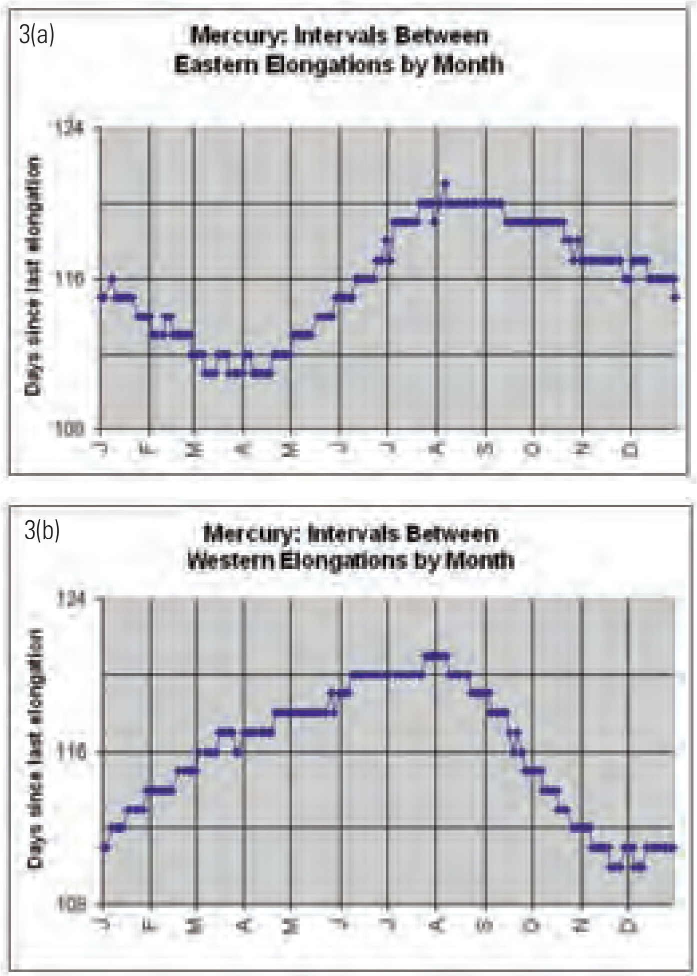


Figure 3 – Applying the same method to consecutive elongations of Mercury reveals an interesting but not-unexpected asymmetry. The elongation points are not 180° opposed on Mercury's orbit, but always occur on the Earthward side of the Sun. The Earth-Sun-Mercury geometry in question is not linear but triangular; the range of intervals is a more moderate 110-121 days. Eastern elongations display a rapid rise to maximum and a shallower decline to minimum; western elongations do the reverse. Think of them as the curves of the same shape waxing and waning. The dates of minimum and maximum are consistent with events straddling the perihelic versus aphelic elongations in the morning and evening sky.

Greenwich Observatory on May 28, 1737 (Ashbrook, 1984).

One interesting project with either inner planet is to observe the phase anomaly known as the Schröter Effect. According to Price *(op. cit.):*

> The times of theoretical dichotomy ('half moon' phase) are calculable with considerable precision yet it invariably happens that at eastern elongation, when Venus [or Mercury] is at the waning part of its phase cycle, dichotomy is 'early' and occurs before the theoretically predicted time. Conversely, at western elongations when Venus [or Mercury] is waning, dichotomy is always late.... (T)he discrepancy amounts to several days and different observers have given different estimates of the discrepancy.... It would obviously be interesting to determine if there is any pattern to these discrepancies. There are, in fact, consistent differences between the observed and predicted phase times over a wide range of phases, not just at dichotomy.
>
> There seems to be no explanation of the phase anomaly. None of the theories put forward is adequate, in particular for explaining the asymmetry of the effect. Atmospheric refraction and irradiation effects have been proposed as explanations but do not account for the leading and lagging phases.

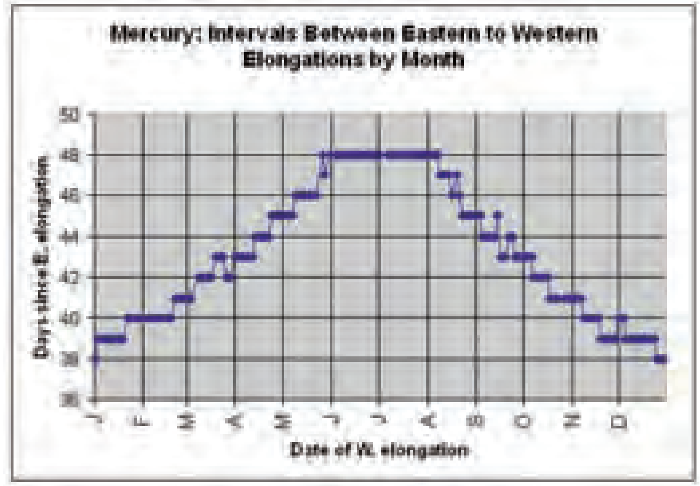


Figure 4 – The interval from evening to morning elongations reaches a minimum of 38 days when Mercury achieves perihelion during the intervening inferior conjunction; the western elongation in such a case occurs about 19 days after December 8. The maximum of 48 days occurs when straddling an aphelic inferior conjunction, with an optimum case occurring about 24 days after June 8. Since events around Mercury's aphelion occur at a more leisurely rate, the June-July maximum is much broader than the minimum.

Weather and my schedule did not permit me to observe Mercury when it appeared exactly at half phase and therefore estimate the duration of this lag for myself; however I was able to observe it on two days when theoretical dichotomy occurred. On July 3 and August 25 of 2005, the ever-reliable *Guide 7.0* calculated Mercury's phase at almost exactly 50%. On both occasions its disc appeared to be a thick crescent, roughly similar to the Moon a day before First Quarter or a day after Last Quarter. This was no personal bias; I asked a number of visitors to the observatory to describe Mercury's shape on both occasions, and there was broad agreement that it was a crescent somewhat less than a "half moon."

My own impression was rooted in considerable experience observing the Moon, where light levels drop off sharply near the terminator where the Sun angle is extremely shallow. In Mercury's case on those days it seemed natural that illumination levels near the terminator had simply dipped below the threshold of visibility, with no definitive "line in between" light and darkness.

The observed phase was less than predicted in both cases, which to my mind is not asymmetrical at all, in fact this explanation would predict the so-called "leading and lagging phases" at the respective eastern and western elongations.

Mercury holds one last surprise for those who might be interested in observing the Schröter Effect. One might expect theoretical dichotomy to always occur at times of elongation, however that is not the case. Mercury's illuminated fraction can range from as little as 36.5% to as much as 63.8% at the moment of maximum elongation (Meeus, 2002). This is again due to Mercury's eccentric orbit, as even at elongation the Earth-Sun-Mercury angle strays far from the perpendicular. Thus theoretical dichotomy can itself be up to five days "early" or "late," even before considering the Schröter Effect.

Mercury will have its moment in the spotlight this November 8, when it will transit the Sun. Observers in North America are favoured for the event, especially those on the west coast. We'll examine this phenomenon further in a future column.

References:

Ashbrook, J. 1984, *The Astronomical Scrapbook* (Cambridge University Press: Cambridge, UK; Sky Publishing Corporation: Cambridge, USA), 209

McCurdy, B. 2005, *JRASC* 99, 72

Meeus, J. 1983, *Astronomical Tables of the Sun, Moon and Planets* (Willmann-Bell Inc.: Richmond), 1-8

Meeus, J. 1983-95, *Astronomical Tables of the Sun, Moon and Planets* (2ed: Willmann-Bell Inc.: Richmond), 18

Meeus, J. 2002, *More Mathematical Astronomy Morsels* (Willmann-Bell Inc.: Richmond), 282

Muirden, J. 1983, *The Amateur Astronomer's Handbook* (3ed: Harper and Row, New York), 158

Price, F.W. 2000, *The Planet Observer's Handbook* (2ed: Cambridge University Press: Cambridge, UK), 75, 129

Bruce McCurdy's mind can often be found at the empty focus of an elliptical orbit, preferably one that's highly eccentric.

Carpe Umbram

by Guy Nason, Toronto Centre (gnason@rogers.com)

Get your motor runnin'
Head out on the highway
Lookin' for adventure
And whatever comes our way

— From: *Born to be Wild* by Steppenwolf (1968)
Words and music by Mars Bonfire (©) MCA

If they had been occultation chasers, Steppenwolf might have included something about loading their vehicle with telescopes, radios, and recorders before they "head out on the highway."

That's what I do. A few times a month, I check over my telescope, mount, eyepieces, short-wave radio, tape recorder, video camera, TV/VCR combo unit, and a whole mess of cables and batteries; load them into my van; and head out to a pre-selected spot in the predicted path of an asteroidal occultation. It requires a fair amount of effort, but I love every minute of it! Of course, "whatever comes my way" isn't always a disappearing star. Often — too often — I watch clouds instead of stars; or some piece of equipment fails at the worst time; or I suffer "pilot error," such as failing to find the target star in time.

Occultation chasing is "Event Astronomy" where time is central to the exercise. It's what makes it so thrilling. Celestial motions pause for no one, so the onus is on the would-be observer to get to the right place at the right time with the right gear to get good data. It's a lot like live television. You know you're going to air at a pre-ordained time and you better be ready and you better do your job right. You can't yell "Cut!" and set up for "Take Two." If you mess up, everyone sees it. On the other hand, the mistake is done and there's nothing you can do except take your lumps and move on to the next "show." Of course, if you do it right, everyone sees that, too. And that's a Good Thing.

An asteroidal occultation occurs when an asteroid happens to pass directly through the line of sight from an observer to a distant star. The starlight is blocked for a short time, ranging from a fraction of a second to half a minute or more. Think of a solar eclipse in miniature. The trick is to be standing in the narrow path of the star-shadow at the right time. That's where the International Occultation Timing Association (IOTA) comes in. More about IOTA in a future column, but for now you should know that some amazingly dedicated people do an astounding amount of work *in their spare time* to publish prediction data for about 300 occultations around the world every *month!* Steve Preston, for instance, publishes a list of upcoming occultations on his Web site at `www.asteroidoccultation.com.` Of course, most of them are out of reach for any one observer. However, if you are willing to drive a hundred kilometres or so, a few will come within range each month. For instance, in November 2005, I found five events that would pass over southern Ontario and within a three-hour driving radius of my home in Toronto.

Even if you are not willing or are unable to, there's a good chance that several asteroidal occultations will come to you every year. During the second half of 2006, for instance, no fewer than 17 asteroidal occultation shadows involving stars brighter than 12th magnitude will pass close enough to Victoria to make it worthwhile for those with fixed observatories there to turn their attention to each occultation for the hour or two it takes to obtain a record of the event. Halifax will be even more blessed. Haligonians will have a crack at 26 events. The rest of us can expect numbers somewhere in between.

How do you find out when and where to look? There are several sources. IOTA President Dr. David Dunham contributed a chapter on the subject in the *Observer's Handbook 2006*, pp. 213-216. Here in the *Journal*, I'll regularly list the better ones that fall across populated parts of Canada, however, both of these sources are impeded by lag times of a few months to a year or more and asteroidal occultation paths are notoriously uncertain until a few weeks, or even days, before the event. Therefore, I strongly recommend frequent visits to the Web site of Steve Preston, IOTA's astrometrist extraordinaire, at `www.asteroidoccultation.com`. There, for each event, you will find maps of the path, finder charts, detailed data on the target star and the occulting body, the phase and proximity of the Moon, and other very useful information for planning your "shadow-time." In addition, I post notices, detailed maps, results, instructional articles, and other information on the RASC Toronto Centre's Web site at `http://toronto.rasc.ca/content/occultations.shtml`. A week or so before each Canadian event on Preston's list, I'll post a notice to that effect to the RASC Yahoo Group and to the Toronto Centre Yahoo Group. If you would like to be advised directly, send me an e-mail (address above) and I'll add you to my contact list.

In future columns, I shall discuss equipment issues, techniques, results, and the value of occultation contributions. I'll also relate occultationists' stories of adventure and, yes, misadventure. For now, please read Dunham's chapter in the *Observer's Handbook*. If you are unfamiliar with the occultation process, visit my article, "How It's Done" at `http://toronto.rasc.ca/content/HowItsDone.shtml`. Below is a list of events that will pass over populated Canadian soil in the next couple of months. Please check Steve Preston's site for updates of events in your area. Give it a go. It's fun and it's useful. Feel free to contact me if you have any questions or concerns.

Guy Nason, Murphy's chronicler from the Toronto Centre, tries to find all sorts of ways to thwart the "Lawgiver of all that can go wrong."

DATE 2006	TIME (UT)	ASTEROID	STAR MAGNITUDE	Δ-MAG	MAX DUR (secs)	PATH
Apr 30	01:02	9 Metis	10.6	0.7	31.6	QC to NS
May 6	05:24	762 Pulcova	11.9	1.5	25.0	MB to NU
May 7	03:44	152 Atala	10.0	3.1	5.3	sw BC
May 8	02:49	560 Delila	11.1	3.5	2.9	NS to ON
May 14	09:40	1736 Floirac	10.3	5.3	2.4	sw BC
May 29	06:39	364 Isara	9.7	3.8	2.6	sw ON
Jun 23	04:32	196 Philomela	12.0	0.5	24.8	QC to ON
Jun 26	04:25	1980 Tezcatlipoca	10.4	4.7	0.7	s SK

A Moment With…

Dr. Alan Hildebrand

By Philip Mozel, Toronto Centre (phil.mozel@sympatico.ca)

Over the past several decades it has become clear that we live in, and are part of, a global environment on planet Earth. Somewhat more recently, we have learned that Earth itself exists in its own milieu: the space environment. Far from being isolated, Earth interacts with surroundings that sometimes, quite literally, have a major impact. This is the realm of scientists like Dr. Alan Hildebrand.

After obtaining his undergraduate degree in geology from the University of New Brunswick, Dr. Hildebrand spent a great deal of time searching for mineral deposits in western and northern Canada. Having an interest in asteroids from the time he was quite young, he eventually obtained a Ph.D. in planetary sciences from the University of Arizona. These sound like disparate endeavours, but not so, as I learned during our interview.

When large quantities of organic material become buried under sediments they may be transformed into oil and gas if exposed to the proper regime of temperature and pressure. Being lighter than the surrounding rock this oil and gas will

Dr. Alan Hildebrand

migrate upward and may become trapped in inverted, bowl-shaped regions of impermeable rock. It is these natural underground storage tanks that modern society would like to tap. It turns out that the uplifted rims of ancient impact craters are potential sites of such reservoirs so knowing their properties will help in the search for oil and gas deposits. One example of such an impact site currently producing these resources is the Steen River crater in Alberta. Although some twenty-five kilometres wide this crater has left no visible surface manifestation since it is buried some two-hundred metres below ground.

A basic question about objects that impact Earth is "What are they made of?" To help find an answer one first needs to find the impactors, so Dr. Hildebrand and his colleagues have set up the Prairie Meteorite Search project. This involves the summertime excursion of a "prairie searcher" into the southern regions of Alberta, Saskatchewan, and Manitoba. Carrying sample meteorites, as well as educational slides and video, the searcher travels from town to town speaking with the media and local people, encouraging residents to bring in their unusual rocks for identification. More than 2700 residents of the prairies have brought their rocks in to be identified. The project has netted nine new meteorites, and 2005 saw a total of four recoveries, a single-year record for Canada.

A particularly exciting find in a different region of the country occurred early in the year 2000 when satellites in space and observers on the ground witnessed a fireball in northwestern Canada. Hundreds of carbonaceous chondrites were recovered from the area around and from the frozen surface of Tagish Lake in British Columbia. This very rare meteorite type is rich in volatile material, indicative of having originated in the cold of the outer asteroid belt. Carbonaceous chondrites are the most primitive kind of meteorite known, preserving a record of a time before the Solar System's formation. In fact, the Tagish Lake specimens may contain more pre-solar material than any others. Dr. Hildebrand, who was involved in the wintertime recovery and study of these meteorites from the northern ice, likens the salvage operation to sampling the surface of a comet.

Dr. Hildebrand has gone after even bigger game. When he returned to grad school he began studying the K/T boundary: the geological borderline between the Cretaceous and Tertiary periods (*i.e.* dinosaurs before the boundary, no dinosaurs after). A new theory at the time was suggesting that a giant impact was responsible for so altering Earth's environment that massive extinctions resulted. Investigating the matter would allow Dr. Hildebrand to pursue his longstanding interest in asteroids and impacts.

Evidence was "piling up" in the form of ancient sediments that indicated an enormous impact occurred coincidentally with the demise of the dinosaurs but the "smoking gun," the crater, was nowhere to be found. Dr. Hildebrand led the team that located it, buried below the coast of the Yucatan in Mexico. And what a monster it is, some 180 kilometres wide, the largest on Earth. As Dr. Hildebrand said in his Helen Sawyer Hogg Public Lecture in 1992, "The K/T impact turned the Earth's surface into a living hell, a dark, burning, sulphurous world where all the rules governing survival of the fittest changed in minutes. The dinosaurs never had a chance" (see the April 1993 *Journal* for the text of this lecture).

To limit the possibility of such catastrophic events happening again, it is prudent to have an idea of the population of near-Earth objects. To this end, Dr. Hildebrand and his colleagues have recently begun operation of a Baker-Nunn telescope at the University of Calgary's Rothney Astrophysical Observatory. With its very wide field of view and modern detectors, the telescope has the potential to capture large numbers of its celestial quarry in exposures lasting only a couple of minutes. Being at a relatively high latitude, the telescope is able to search regions of the sky not searched by other observatories.

Furthermore, knowing the whereabouts of near-Earth asteroids is a first step in visiting them and, ultimately, making use of their resources. While the cost of returning asteroid material to the Earth's surface will be prohibitively expensive for the foreseeable future, we don't have to go that far. The material may be used just where it is (*i.e.* in space), in the construction of, for example, solar-powered satellites that may help supply our energy needs.

Ultimately, Dr. Hildebrand will be going into space to conduct his research - in a virtual sense at least. He is working with the Canadian Space Agency on *NEOSat,* a microsatellite that, after its planned launch in 2008, will hunt for asteroids that cross Earth's orbit. A class of asteroids known as Atens, which spend much of their time close to the Sun as seen from Earth, will be a prime target since *NEOSat* will be able to hunt effectively in the Sun's glare.

In the early 19th century, those astronomers who hunted asteroids called themselves "celestial police." Dr. Hildebrand is one of a number of Canadian cops who will ensure that, if the world ends, it may be with a whimper, but certainly not a bang.

Philip Mozel is a past Librarian of the Society and was the Producer/Educator at the McLaughlin Planetarium. He is currently an Educator at the Ontario Science Centre.

Society Donations Report

by Denis Grey, Chair Membership and Promotion Committee (denis.grey@sympatico.ca)

In the August 2005 issue of the *Journal* I introduced the new **Sustaining Membership** program as a way of encouraging donations to the Society. In 2004, the average RASC member had donated only $0.56 to the National Society. In 2005 we increased that number substantially to either $2.40 per member or $8.69 per member depending on your point of view.

The reason for this ambiguity was that a large portion of our donations in 2005 was the result of the extraordinary generosity of ***Walter A. Feibelman*** who donated nearly $28,000 Cdn as part of his estate. Taking this major gift out of the equation still leaves the RASC with $10,678 in donations for the year ($2.40 per member) - a 429% increase over 2004!

Here is a summary of 2005 donations as processed by National Office:

2005 Society Donations Summary

Sustaining Memberships	
Society Portion	$2,014
Centre Projects Fund	$1,335
Sub-total	*$3,349*
Special-Purpose Funds	
Endowment Fund	$1,060
Northcott Education	$1,273
Sub-total	*$2,333*
Society Donations	
General unrestricted	$2,366
Explorons l'astronomie	$1,000
President's Travel	$1,630
Sub-total	*$4,996*

Total Regular Donations	**$10,678**
Feibelman Estate	$27,951
Total Society Donations	**$38,629**

In addition to these donations to the Society as a whole, donations were received by the Society and directed to Centres through the National Office reporting system. The total amount of these donations was not available at the time of this writing.

Your generosity means that the RASC will be able to undertake more projects in 2006 and build our capability for promoting astronomy and the allied sciences in the year to come; in particular, the donations to the new ***Centre Projects Fund,*** which will allow the National Society to support projects at the Centre level without impacting the operating budget. In addition, there have been substantial donations to the ***Ruth Northcott Fund for Education*** and the ***Peter Millman Endowment Fund*** that will assist with the promotion of astronomy education and long-term growth of the Society respectively.

We encourage the membership to continue with this trend of increased financial support to the Society. In these times of reduced publication revenues and increased membership service costs, the Society must turn more to donations as a source of funding for both its operations and its mandate projects.

The Membership and Promotion Committee is pleased to acknowledge publicly the generosity of our members who made donations to the Society in 2005. In addition to the names listed here there are also numerous donors who wished to remain anonymous. Each donor has the thanks and appreciation of our Society.

Centre Donations

Donations to Centres that were processed by the Society (Centres noted in brackets).

Important Note:

This report does not include amounts reported by Centres who manage their own charitable donation receipts. The total amount of such donations will be given in the 2005 Annual Report. Recognition of such donations is managed by the appropriate Centre.

Robert G Anderson (Hamilton)
Doug Angle (Kingston)
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The Atlantic Space Science Foundation (Halifax)
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William Bell (Unattached)
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Donations to the Society for its operations and activities.

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Peter Millman Endowment Fund

The Millman Endowment Fund was established to assist the Society with its long-term growth and capacity-building.

In the name of Carlos Beca
Ross Blakey
Nathaniel Chafee
Charles Deary
Randy Dodge
R. Garstang
Herman Genschorek
Gert Jahncke
David Patterson
In the name of Marjorie Rahim
Patrick Saxton
Osao Shigehisa
Gordon Tulloch
Gene Wilson

Ruth Northcott Fund for Education

The Ruth Northcott Fund supports a) the improvement and extension of the publications of the Society; b) the improvement and extension of the library and visual aids of the Society for the benefit of the members of the Society; c) the fostering of communication and interchange among the members of the Society; d) assistance in providing accommodation for the Society's undertakings; e) such other purposes consistent with her wish to further the study of astronomy in Canada.

R. Boudreau
David Brozovsky
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R. Garstang
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Denis Grey is a Sustaining Life Member of the RASC Toronto Centre where he enjoys an excellent selection of 1st, 2nd, and 3rd magnitude stars.

A Special Bequest - Walter A. Feibelman

by David Clark, National Treasurer

It was with regret the Executive learned this fall of the passing of Walter A. Feibelman. Feibelman joined the RASC in 1953. He was a scientist at NASA's Goddard Space Flight Center for 33 years before retiring in 2002. Feibelman continued at NASA doing research as an emeritus astronomer. His research mainly involved planetary nebulae and symbiotic stars, which he studied with the *International Ultraviolet Explorer* orbiting observatory. A discovery for which Feibelman is well-known is Saturn's E ring. He found the ring in 1966 during Saturn's ring-plane crossing, in a deep exposure of the planet made at Allegheny Observatory. Feibelman was also a long-time member of the AAVSO and contributed observations made with the *IUE*. Feibelman often incorporated observations made by amateur astronomers into his own research.

The RASC graciously thanks Walter A. Feibelman for listing the Society as a beneficiary to his estate. The Society has received an amount of $24,225.48 US or $27,951.36 Cdn. It is not clear at this point in time whether U.S. income tax is due on some portion of this amount, as the estate was distributed prior to payment of income tax on income investments. Although it is believed our status as a charitable organization will render this donation tax free, this has not yet been confirmed. The amount has been placed into our investment account while we discuss the proper usage of this generous gift. The Feibelman estate has placed no stipulation on its use.

On behalf of the RASC, I thank Mr. Feibelman for his kind support of our Society and astronomy in Canada.

WEB ACCESS TO THE 2006 ISSUES OF THE JRASC

The 2006 issues of the *Journal* can be accessed from the RASC Web site at `www.rasc.ca/currentjrasc` (userid="jrasc"; password="pelican"). Issues are posted immediately after the final production version is complete.

Strengthening the Society Through Planned Giving

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

Have you ever thought of how you could make a permanent, long-term influence on the well-being of your favourite Society (meaning the Royal Astronomical Society of Canada, of course)? Perhaps you should — there are benefits for both you and the Society.

The Royal Astronomical Society of Canada (RASC) is ready to expand the program for people to support the Society in ways that are probably familiar to some, possibly new to others. It's called **Planned Giving** and it means you plan to donate some cash upfront, or write a clause in your will to leave all or part of your estate to the RASC, or designate the RASC as the beneficiary of one of your life-insurance policies. Consider the recent example of the late Walter A. Feibelman, who left a sizeable amount designated in his will (see the sidebar in the foregoing "Donations" article).

A planned gift can be given to the Society without conditions but it also allows you to contribute to a specific project or initiative that you may wish to promote. For example the Ruth Northcott Education Fund was set up by Miss Northcott specifically to advance projects related to astronomy education. A planned gift could be earmarked for such initiatives as:

- the **Centre Projects Fund** - this new fund has been established to help finance astronomy projects initiated and managed by RASC Centres;
- the **National Observatory Project** - to help fund the establishment of a network of Canadian robotic observatories;
- an **RASC scholarship** - for astronomy studies at one or more Canadian universities; or
- a new **RASC award** - for the advancement of astronomy in Canada.

Some members already donate cash to the Society, and in turn receive a receipt to help reduce the burden of income tax.

Donors who include the Society in their estate planning will receive immediate recognition for any gift that is made without conditions. The goal of the RASC's Planned Giving Program is to maximize the benefits of a charitable gift for the donor, for the donor's family, and for the Society.

Interested members pledge to support the Society through a variety of planned gifts such as will bequests, securities, life insurance policies, or gifts of cash. Because tax laws favour charitable gifts, planned giving can be a way for donors to show their support and realize substantial tax savings. Whatever form your gift takes, you can have the satisfaction of knowing you have made a significant gift to the RASC.

Donors have three distinct ways to make contributions:

Gifts of Cash

An outright gift of cash is certainly the simplest method of giving. When you make a cash gift, you receive a tax receipt for the amount of your gift, and you receive the satisfaction of knowing that your gift will be used to continue the work of promoting astronomy in Canada. The money can be designated to go straight toward operating costs - it offsets part of the current budget; or you can elect to place it into either the Ruth Northcott Education Fund or the Society's Endowment Fund.

Will Bequests

You may wish to make a gift to the Society by taking advantage of one of the easiest, most frequently used methods — a bequest in your will. Tax laws favour bequests, and consequently they are an excellent way to support the Society. As above, the money can be designated to a specific area or fund in the Society accounts.

Gifts of Life Insurance

A life-insurance policy may offer a simple way to support the Society, particularly if your family no longer needs life insurance for financial security after your death. One way to make a gift of life insurance is to make the RASC the owner and beneficiary of a new policy. Your payments for the new policy would be eligible for tax credit. An alternative is to make the RASC the owner of an existing policy allowing you an immediate tax benefit.

Maximize the Benefits

We encourage you to plan your gift for maximum benefits. We are confident that, whatever form your gift takes, it will bring you the satisfaction of knowing you have made a significant contribution to help the RASC continue to promote science and astronomy for years to come.

As you begin planning your gift to the Society, we suggest you consult your own legal and financial advisors to achieve the maximum benefits.

Individuals who wish to support the RASC through will bequests and other planned gifts can contact any member of the Membership and Promotion Committee (MAP) (email: `map@lists.rasc.ca`) or call the National Office (toll free at (888) 924-RASC (7272) in Canada or (416) 924-7973 in Toronto) for direction on which type of planned gift can work best for you. We would be pleased to discuss a gift that best meets your needs. Any gift, large or small, is welcome.

James Edgar is an RASC Life Member, attached to the Regina Centre, and is also a member of the Membership & Promotion Committee.

Reviews of Publications
Critiques d'ouvrages

Sky Phenomena: A Guide to Naked-eye Observation of the Stars, by Norman Davidson, pages 207 + xvi, 18 cm × 24 cm. Lindisfarne Books, 2004. Price $25.00 US softcover (ISBN 1-58420-026-X).

This very interesting book reflects several of the author's major interests during much of his life. Born in Scotland, Norman Davidson was a practicing journalist (for ten years) and teacher (for sixteen years) in England, where the subjects he taught included astronomy, history, and literature. Subsequently, after moving to the U.S., he served for ten years as director of a teacher-training institution. His primary goals, as seen in the obvious aims of his book, have been associated with bridging the proverbial gap between the arts and sciences and with the education of adolescents and adults in both areas of human endeavor.

The first indication that *Sky Phenomena* is as much about the "art of observing" as about the "science of the sky" is the reproduction on the cover, not of a star map or astrophoto, but of Van Gogh's famous painting Starry Night. The second indication is the rather wordy, but factual, subtitle given on the title page: "A Guide to Naked-eye Observation of the Stars with sections on poetry in astronomy, constellation mythology, and the Southern Hemisphere sky." The author evidently realized that there exist numerous volumes already providing the beginning amateur astronomer with very worthwhile introductions to the stars, constellations, planets, and celestial phenomena— one could list Terence Dickinson's *Nightwatch* and *Summer Stargazing* and our Society's *Beginner's Observing Guide* as examples. Davidson's wish was rather to supplement such observing guides with a volume that provided a cultural and historical background for those learning the night sky, and to provide teachers of introductory observational astronomy courses with a selection of practical exercises to assist in teaching the movements, patterns, and events associated with our objects of interest. His book, in this reviewer's opinion, is one that should be very valuable for teachers who wish to explain a good number of celestial events, all of which can be observed with the naked eye alone, and by their students and amateur astronomers in their quest to understand the cultural and historical background for many such events.

The first two chapters are devoted to understanding the diurnal and annual motions of the stars and constellations, and subsequent chapters to the understanding of the apparent motions of the Sun and the Moon. Almost every page has one or more sketches to illustrate the ideas being explained, and all of the drawings are well integrated with the text in a way that avoids turning pages to locate the relevant sketch.

A fine example of the interesting way in which Davidson presents his information in the early chapters is provided by his detailed story in chapter three of how Captain Cook determined position at sea during his long second voyage to the South Pacific (1772-1775), and especially how the recent invention of a reliable chronometer enabled accurate determination of longitude. His crew, we are told, on the night of March 24, 1773, observed the south celestial pole to be 46 degrees above the southern horizon, and the next day, with the Sun on the meridian (at noon), confirmed their latitude by observing it 46 degrees above the northern horizon, and simultaneously noted that their chronometer (running on Greenwich time) was 11 hours 4 minutes slow. The question is asked: "Where is the ship?" With the information provided, the student can easily respond. Since 4 minutes of time are equivalent to 1 degree of longitude, the 11 hours 4 minutes (or 664 minutes) correspond to 166 degrees (664/4) east of Greenwich. Soon afterwards Cook's crew sighted the southern tip of New Zealand and anchored in Dusky Bay. The author, in summary, concludes that section of the book by stating: "Such then are the basic movements of the Sun and stars seen from Earth and their importance for human life on land and sea. Without a knowledge of the heavens, human beings are lost on Earth. Time and space elude their grasp."

The observer and teacher alike will gain from carefully reading the chapter devoted to, and named, The Copernican Revolution. The contributions of Tycho Brahe, Copernicus, and Kepler are presented in a straightforward manner, easily understood by someone reading them for the first time. Especially intriguing is the narration of how Kepler came to his esoteric idea about planetary distances, namely that the orbits of the five bright planets could be explained in terms of five Platonic solids, ranging from Mercury's orbit pictured as the insphere of an octahedron to Saturn's orbit viewed as the outsphere of a cube. Though often dismissed as fanciful and inaccurate, a recent reassessment of Kepler's "Platonic solids" idea has concluded that its fit with the observed planetary orbits "is very good." With his careful illustrations, Davidson has given amateurs a rare chance to grasp the actual meaning of the idea. Most introductory texts are concerned only with Kepler's three laws of planetary motion.

The chapter devoted to comets and meteors is especially interesting, as well, in offering a practical way in which the teacher can use Pascal's Theorem to help students understand cometary orbits. A chapter devoted to the southern sky contains valuable insights that should be read by every observer, even if he or she has never had the chance to observe those stars. The book's longest chapter, The Stars in Poetry, at 43 pages, contains a wonderful selection of poetry in many genres and from many periods of history: from the Rig Veda of ancient India and the Egyptian Book of the Dead to North American aboriginal songs, and including Chaucer, Shakespeare, Goethe, Blake, Tennyson, Wordsworth, and many others.

There are seven appendices, one of which, The Glossary of Astronomical Terms, is an excellent and comprehensive list of words, very clearly explained. While many such lists, for example, define heliacal risings and settings, this one even explains acronical and cosmic risings and settings. Five of them are lists: famous astronomers, teaching resources, astronomical symbols, Solar System data, and future celestial events (eclipses, planetary elongations, and oppositions) up to the year 2017. One appendix, the all-sky star maps, is positively disappointing, with the maps being very small (only 9 cm across), only three in number, and showing only the very brightest stars.

In the main text of the book, only one convention is somewhat unusual, and at times even distracting: the practice of Anglicizing the traditional Latin names of the constellations. British readers were once comfortable with the Big Dipper being called The Plough; modern North American readers are not so inclined with Aries, Taurus, Cancer, and Leo being named Ram, Bull, Crab, and Lion, and with the zodiacal constellations south of the equator being labeled Scales, Scorpion, Archer, Goat, Waterman, and Fishes. Notably, that convention was not continued in the Glossary of Astronomical Terms.

Sky Phenomena is, in general, a clear, practical, well-organized guide to observing the sky with the unaided eye for both the amateur astronomer who wishes to see the heavens in a cultural and historical context, and for the teacher who wants her/his student to see celestial events in a different way.

— Leo Enright

An active member of the Kingston Centre, Leo Enright has been an astronomy writer, educator, and observer for many years.

Albert Einstein's Vision: Remarkable Discoveries that Shaped Modern Science, by Barry Parker, pages 286, 16 cm × 24 cm. Prometheus Books, 2004. Price $28 US hardcover (ISBN 1-59102-186-3).

The year 2005 was a banner year for books about Einstein and Physics, no doubt because the United Nations declared 2005 to be "The Year of Physics." (From the Web page, `www.physics2005.org`, I quote: "The year 2005 marks the 100th anniversary of Albert Einstein's 'miraculous year' in which he published three important papers describing ideas that have since influenced all of modern physics. This year provides the opportunity to celebrate Einstein, his great ideas, and his influence on life in the 21st century.")

In a nutshell, that is what Parker's *Albert Einstein's Vision* is all about. The preface makes reference to two previous books by Parker on Einstein: *Einstein's Brainchild: Relativity Made Relatively Easy* and *Einstein: The Passions of a Scientist.* I am guessing there is some overlap between the three. Here are the chapter titles for *Albert Einstein's Vision,* with my capsule summaries:

1. Twists in the Fabric of Space (special and general relativity)
2. Expanding to Space (cosmology)
3. Black Holes, Wormholes, and other Demons (black holes and wormholes)
4. The Mystery of Time and Time Travel (causality and time travel)
5. Ripples in the Curvature of Space (gravitational waves)
6. Gravity's Cosmic Lenses (gravitational lenses)
7. Einstein's Quantum Legacy (quantum controversy)
8. Superbombs (plutonium and hydrogen bombs)
9. Other Einstein Insights (photons, lasers, Bose-Einstein condensate)
10. Dreams of a Unified Theory (uniting gravitational, electromagnetic, atomic, and nuclear fields)
11. Strings and Superstrings (modern unified field theories)
12. Beyond Superstrings (membrane theory)

Each topic is treated in about the same way: first the author introduces Einstein's work in the area, which in most cases was fundamental, but not exhaustive. Then the author describes how other 20th-century physicists developed the ideas (not always with Einstein's blessing). He concludes with an evaluation of the current state of knowledge and "what Einstein might think today." (I am simplifying things, since not all chapters are exactly like that.)

So much for the facts, now for the assessment. I must confess that if I had flipped through the book in a bookstore, I would probably not have paid the price for it. There are many books on the same subjects available these days; the variety is bewildering. As a physicist myself, I studied some of the topics in university, even at the post-graduate level, but I did not continue to work in the area of modern physics. I have read many popular books on contemporary physics, and they all essentially cover the same material to the same depth. For myself, I would like to study some of the topics in more detail, rather than read another overview. That is not to say that Parker's book would not appeal to another reader, but it might not be suitable for a beginner, either. There are better beginner-level books on all of the topics. *Albert Einstein's Vision* might be best for someone who has mastered the introductory-level material, and is interested in how Einstein's work fits into the context of 20th-century physics.

What Parker has done is to review Einstein's ideas near the start of the 20th century, and to draw the links between those ideas and the development of physics through the rest of the century to the present day. His approach is interesting, and I did learn a few things. What I learned was that Einstein was a deep thinker and remarkably jealous of his ideas. He did not always like what people did with them. He thought that the mathematical derivation of the co-ordinate singularity that is the basis for black-hole theory must have been a mistake. Even though he made some fundamental contributions to quantum theory (the quantum nature of light, for example), he could never accept the probabilistic interpretation of quantum theory as developed by others. His famous equation stating the equivalence of mass and energy was the basis of the atomic bomb, which he abhorred. Also, he was not happy with the American custom of submitting proposed scientific papers to an anonymous, qualified, reviewer for comment and possible alteration before publication.

My favourite chapter was on cosmology; however, I do not like the way that most authors write about the Cosmological Constant. (Parker does a better job than most.) That requires a short digression: Einstein's equations for general relativity are based on a least-action principle, which is common to all classical and quantum field theories. One starts with a Lagrangian, which is function of all the field variables in the theory. In simple terms, the Lagrangian of the system under study is the difference between the kinetic-energy density and the potential-energy density. The equations of motion — that is, the differential equations describing the spatial and temporal evolution of the field variables — derive from the principle that the "action" (the integral of the Lagrangian over space and time) is a minimum for the actual system trajectory. The principle of least action is used as a fundamental assumption, and Newton's laws, Snell's law of refraction, and other laws can be derived from it. Physicists looking for fundamental equations for classical and quantum systems typically start by inventing Lagrangians, then look for the consequences of their inventions and see if they fit observations.

An important byproduct of such an approach is that one can connect conservation laws of the system with symmetries of the

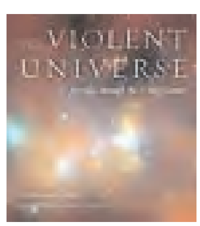
Lagrangian. That is, if one transforms the field variables in certain ways, the Lagrangian is "symmetric" if it is unchanged. (Geometrically, if one rotates a square 90 degrees around its centre, it is symmetric because it ends up looking the same.) Such Lagrangian symmetries are important if one wants a theory to have conservation laws of energy, momentum, and so on. Einstein's field equations for the large-scale structure of the Universe — in their most general form — contain a term that is a combination of gravitational fields multiplied by a constant, which is called the Cosmological Constant (CC). There was no reason to exclude the term, as it did not spoil the symmetries of the Lagrangian, and there is no way of pre-determining what the value of the constant should be. Einstein reluctantly attributed a specific non-zero value to the CC, to keep the Universe stable. At the time, little was known about the Universe, but it seemed sensible that it should be stable, as otherwise it would either expand or collapse. Later, Slipher, Hubble, and others determined through careful observation that the Universe appeared to be expanding. As a consequence, Einstein immediately retracted his non-zero CC. It is interesting, however, that more recent observations and cosmological theories are not as cut-and-dried as in Einstein's day. It may now be necessary to introduce a CC with a non-zero value, to fine-tune the expansion rate. The point of the matter is that the CC debate is not a yes/no matter, it is a question of "what value fits the observations?" Human as he was, Einstein regarded his invocation of the Cosmological Constant as a "blunder," but he might have been closer to reality than he thought he was.

The illustrations in the book are simple and adequate. I especially like the original sketches of the principal figures of the story (presumably based on photographs). They give the book a uniform look.

There is no doubt that Einstein was a deep thinker who definitely thought "outside of the box." He was not always right about everything, but that simply confirms that science is a human endeavour, subject to human frailties. Even so, he had a remarkable number of radical ideas about physics that worked out, and without a doubt he made his mark on 20th-century physics, as Parker attests.

— David M.F. Chapman

David M.F. Chapman is a Life Member of the RASC, and a Past-President of the Halifax Centre. He recently stepped down as a Contributing Editor of JRASC, *after completing his 50th* Reflections *column. By day, he applies what he remembers about physics at Defence Research and Development Canada - Atlantic in Dartmouth, Nova Scotia.*



The Violent Universe: Joyrides through the X-ray Cosmos, by Kimberly Weaver, pages 195; 23 cm × 25.5 cm, The Johns Hopkins University Press, 2005. Price $35 US hardcover (ISBN 0-8018-8115-3).

The *Chandra X-ray Observatory* has put X-ray astronomy front and centre, mainly thanks to the Astronomy Picture Of the Day Web site `http://antwrp.gsfc.nasa.gov/apod`), which profiles many images from the X-ray space telescope. The title of the book gives a strong hint about how X-ray imagery portrays the violent energy originating from supernova eruptions, galactic collisions, and stellar implosions. The resulting multi-million degree plasmas that pervade space are a major component of the cosmos. While amateur astronomers mostly concentrate on what can be seen in the optical region of the spectrum, this book opens up a new world for consideration by illustrating how scientists make use of X-ray observations, as well as light from the radio, infrared, and visual regions of the electromagnetic spectrum. The author cleverly demonstrates how, through use of images obtained in multiple spectral regions, so much more can be discerned and learned about the cosmos.

The degree and scale of violence in the cosmos is largely responsible for how our Universe currently exists and how it is evolving. The author explains how such processes work in easy-to-understand language, and illustrates them with diagrams and beautiful colour images derived from X-ray energy — the best way to see the violence in action. Through X-ray astronomy, scientists are beginning to understand previously unsuspected states of matter and physical processes, especially dark matter and dark energy. We have relied upon traditional optical-light observations in the past, which have kept us in the dark, so to speak.

Over the last 40 years or so, X-ray detectors have increased a billion times in sensitivity. Largely, that can be attributed to the *Chandra* X-ray telescope's prime location in space and the superb resolution it offers scientists. Understanding the origin and evolution of the Universe would not be possible without the X-ray spectrum. This book illustrates that fact in an entertaining way mere mortals can understand.

I plan to use the book to supplement my visual observing of "faint fuzzies" through my amateur telescope. Never again will the Crab Nebula look the same after viewing the nine images of the Crab Nebula in this book, and how well they illustrate the violent processes that are currently underway. Likewise, when I observe the Orion Nebula I now know the huge gas cloud surrounding the nebula is at least four times larger than we can observe visually.

At first glance *The Violent Universe* appears to be a coffee table book, since it is beautifully printed, with numerous superb images showing lots of colours and fascinating detail. As soon as the accompanying text is read, however, it is apparent the author knows the subject well. Kimberly Weaver presents a good balance of interesting facts that will keep the non-astronomer happy, and also extends the science to ensure the serious amateur astronomer will not be left wanting.

The author confesses that scientists are poor communicators. She further confesses that explaining what she does to her family and friends is difficult. Her motivation for writing the book was to explain X-ray astronomy to everyone: her friends and family, as well as you and me. She has succeeded!

— Joe Carr

Joe Carr is the webmaster and 2nd Vice-President for the Victoria Centre, and is a Life Member of the RASC. He claims to be a rank amateur astronomer, and only keeps up with more-skilled observers by performing tricks with his various gadgets. He is a dedicated astrophotographer, and enjoys the technological convergence of photography, astronomy, and the Internet.

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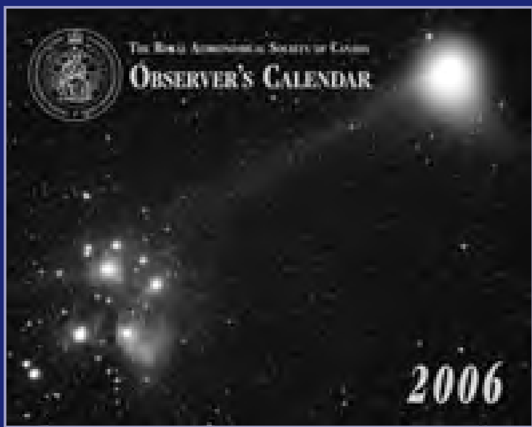
Observer's Calendar — 2006

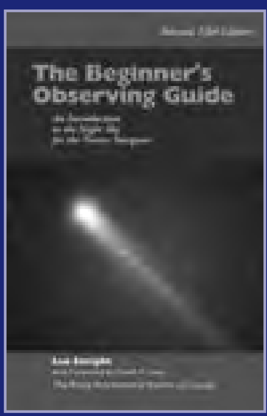


The award-winning RASC Observer's Calendar is your annual guide

Created by the Royal Astronomical Society of Canada and richly illustrated by photographs from leading amateur astronomers, the calendar pages are packed with detailed information including major lunar and planetary conjunctions, meteor showers, eclipses, lunar phases, and daily Moonrise and Moonset times. Canadian and U.S. holidays are highlighted. Perfect for home, office, or observatory.

Individual Order Prices:
$16.95 Cdn/ $13.95 US
RASC members receive a $3.00 discount
Shipping and handling not included.

The Beginner's Observing Guide



Extensively revised and now in its fifth edition, The Beginner's Observing Guide is for a variety of observers, from the beginner with no experience to the intermediate who would appreciate the clear, helpful guidance here available on an expanded variety of topics: constellations, bright stars, the motions of the heavens, lunar features, the aurora, and the zodiacal light. New sections include: lunar and planetary data through 2010, variable-star observing, telescope information, beginning astrophotography, a non-technical glossary of astronomical terms, and directions for building a properly scaled model of the solar system.

Written by astronomy author and educator, Leo Enright; 200 pages, 6 colour star maps, 16 photographs, otabinding.

Price: $19.95 plus shipping & handling

Skyways: Astronomy Handbook for Teachers

Teaching Astronomy? Skyways Makes it Easy!

Written by a Canadian for Canadian teachers and astronomy educators, Skyways is Canadian curriculum-specific; pre-tested by Canadian teachers; hands-on; interactive; geared for upper elementary, middle school, and junior-high grades; fun and easy to use; cost-effective.

Skyways is complete with conceptual background; teacher information; student worksheets; resource lists; Canadian contributions to astronomy section; FAQs; and more. Written by Canadian author and RASC member, Mary Lou Whitehorne.

Price: $16.95 Cdn (members); $19.95 Cdn (non-members)
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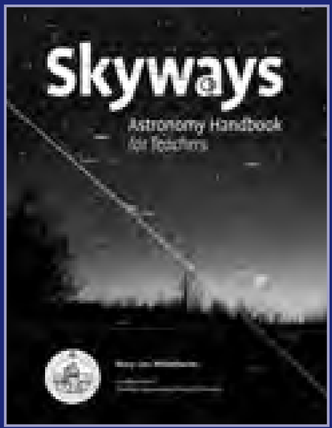

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