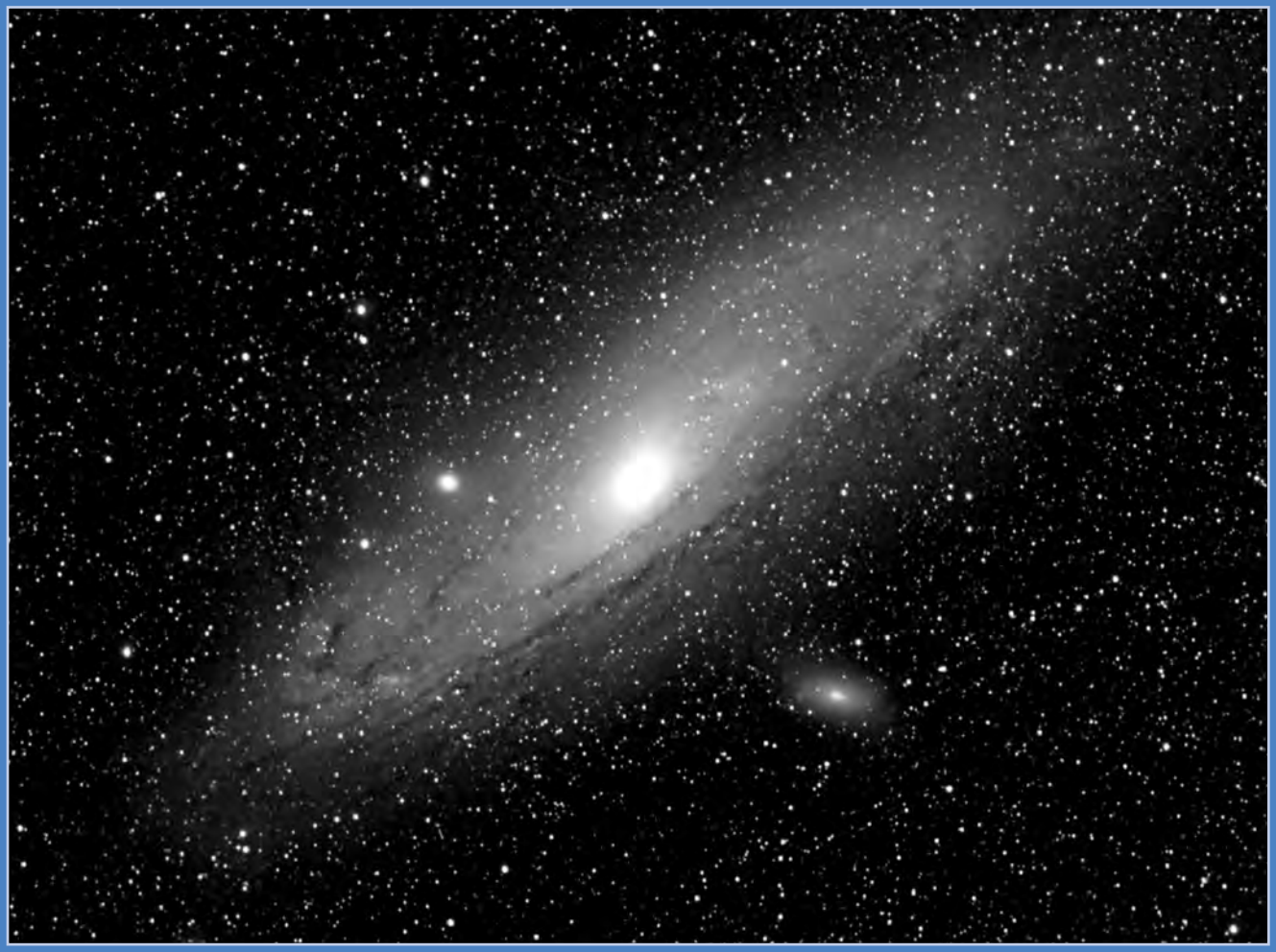
June/juin 2001 Volume/volume 95 Number/numéro 3 [688]

Journal

The Journal of the Royal Astronomical Society of Canada Le Journal de la Société royale d'astronomie du Canada



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June/juin 2001

Journal

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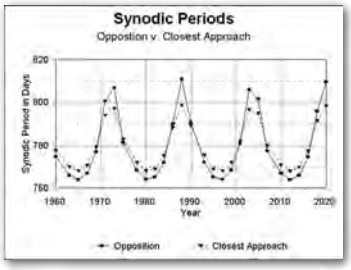

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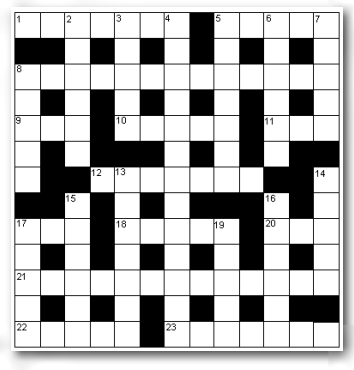

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Cover:
Gallery — a superb collection of CCD images of the heavens by Jan Wisniewski, Kingston Centre. Shown on the cover is his rendering of the Andromeda Galaxy (M31)

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President's Corner

by Robert F. Garrison (garrison@astro.utoronto.ca)

It's that time of year again. All the taxpayers, accountants and auditors are working to meet the end-of-April deadlines. Students and faculty in the universities are deeply involved with the end-of-term testing and evaluation frenzy, while the administrators are frantically working on budgets for next year. It seems that the whole world is tense, with uncertainty in the stock markets contributing to the anxiety level.

What happened to the academic's quiet life of intellectual contemplation? Who seeks knowledge for its own sake (versus training)? Actually, the image the public has of the academic life hasn't been much in evidence for decades, at least not in the sciences. I don't know any of my colleagues in astronomy who put in fewer than 70-hour weeks, and some put in much more. Most of the extra work can be ascribed to a marked increase in red tape. When the Harris government passed legislation favouring 60-hour weeks, we joked that we would have to cut back to meet their standards.

The 2001 General Assembly in London is developing well. It may turn out to be the largest ever. One indication is that there will be a larger-than-usual number of awards, which the organizers of the meeting have decided to spread out to different parts of the meeting to avoid award burnout.

One of the awards will be to the city of Oshawa for its enlightened lighting policy; perhaps I should say we hope they are de-lighted with the award. (I couldn't resist that one, Peter!) I have heard from Dr. David Crawford, founder of the International Dark Sky Association and honorary RASC member, that he and his wife Mary will attend the GA in London. David is a retired Kitt Peak astronomer, who was, among many other things, Project Scientist for the Kitt Peak and Cerro Tololo 4-m telescopes. Dave loves to talk about the IDA and is very approachable, so be sure to seek him out if you want to ask questions about lighting problems or successes.

The amount of talent and dedication among the RASC members never ceases to amaze me. This year's Annual Report is an outstanding example. To save costs, the Executive Committee asked for volunteers to take over the design and layout instead of paying large amounts of money to have it done by outsiders. While we were anticipating a plain, utilitarian document, Mark Bratton (Montreal) stepped forward, put in an enormous amount of work and, by all accounts, produced a great-looking Annual Report. This is the ideal example of professional work done for the love of it, which is what "amateuring" is all about. As the membership approaches 5000, we probably encompass most professional and skill levels. The potential for achieving great goals is there to be tapped. The sky is the limit.

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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MacNab Printers Ltd.

The *Journal of The Royal Astronomical Society of Canada* is published at an annual subscription rate of $80.00 by The Royal Astronomical Society of Canada. Membership, which includes the publications (for personal use), is open to anyone interested in astronomy. Annual fees for 2001, $40.00; life membership is $800. Applications for subscriptions to the *Journal* or membership in the RASC, and information on how to acquire back issues of the *Journal* can be obtained from:

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

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

U.S. POSTMASTER: Send address changes to IMS of NY, P.O. Box 1518, Champlain, NY 12919.
U.S. Periodicals Registration Number 010-751.
Periodicals postage paid at Champlain, NY and additional mailing offices.

 ISSN 0035-872X

Editorial

by Doug Hube, Associate Editor (dhube@phys.ualberta.ca)

We are now into the fifth year of the new *JRASC*. Given the large increase in membership in recent years, for many members this is the *only* format in which you have seen the *JRASC*. The first serious discussions within National Council, and most of the important decisions that led to the publication you are now reading, were made during my tenure as National President; however, those decisions were *not* made at my instigation. Indeed, if you listen carefully you may still be able to hear the sound of my feet dragging!

They drag no more, and I regret not being able to take any credit whatsoever for what has become a very successful publication.

As compared to the old, small format, research-intensive *JRASC*, the new version has a more eclectic mix of material with a much greater appeal for the *amateur* astronomer. Nevertheless, there is a place for the *professional* astronomer in these pages, and every issue has contained at least one peer-reviewed research paper. While most professional astronomers may aspire to publish their papers in *The Astrophysical Journal*, *The Astronomical Journal*, *Nature*, and the like, it is the case that some research papers are not suitable for those journals which favour astrophysics over astronomy. The new research results presented in such papers are still deserving of becoming part of the permanent record of discovery and understanding of the astronomical universe. As evidenced by the significant (and interesting) research papers that have been published here, the *JRASC* has a valuable service to offer the professional community.

The *JRASC* serves other functions for the professional community. For example, the *JRASC* helps to keep the community of amateurs, and through them, the general public, apprised of astronomical developments and discoveries made by Canadian astronomers. Canada has a long tradition of excellence in both astronomy and astrophysics, and its record of achievement continues to grow apace. Scientific research in the modern era is expensive. Lobbying government agencies for financial support is a regular activity of the Canadian Astronomical Society/La Société Canadienne d'Astronomie (CASCA) and of its members. Members of the RASC have been called upon to support those lobbying efforts and I assume some have done so. The altruistic lobbying by amateur astronomers may carry as much weight as lobbying by professionals who have the most to gain directly by increased government funding.

Within Canada, because of the long tradition referred to above, we have individuals whose careers extend back to the early days of radio astronomy, and to the days when the universe seemed much simpler than we now know it to be. There are stories to be told, and histories to be recorded and preserved. The pages of the *JRASC* are an ideal place for that. One Canadian pioneer in radio astronomy has been invited to tell his story here. Others will be approached. If you have a story that needs to be told, do not wait to be invited.

There is no astronomical topic that should be excluded from these pages. There is no one who should be discouraged from submitting publishable material which is of broad interest and which meets our high, but reasonable, standards in terms of language and credibility. The *JRASC* is the publication of choice for *all* astronomers in Canada, whether young or old, beginner or advanced, professional or amateur. Read it, learn from it, and enjoy. Contribute and enjoy it even more.

Correspondence
Correspondance

PYRAMIDS

Dear Sir,

I enjoy reading the *Journal's* historical articles but noticed a blunder in the caption identifying the Gizeh pyramids, which grace the cover of the December 2000 issue. The caption inside identifies Khufu's pyramid as the centre one of the triplet; his pyramid is, in fact, the right-most one in the photo. The centre pyramid is that of his successor, Khafre.

Mitchell Struble
Pennsylvania, USA

STARFEST 2001

STARFEST 2001, the twentieth annual Observing Convention and Star Party of the North York Astronomical Association, will take place on August 16–18, 2001, at the River Place Campground, Mount Forest, Ontario, Canada. Starfest offers a wide variety of observing-oriented activities that address the needs and interests of experienced observers and astrophotographers, as well as those of people new to the hobby. Activities include observing sessions, formal and informal presentations, workshops, commercial exhibits, and a children's program.

This year's theme, The Universe — A Spectrum of "Light," examines how modern astronomers use a wide array of instruments to probe the mysteries of the universe. The results of their work have given us new insight into the nature of the universe, its origin, and its destiny. These instruments span the entire spectrum from extremely high-energy gamma rays to metre-long radio waves. Join us for a fascinating look at our universe through the "eyes" of these unique instruments.

Detailed information can be obtained by visiting our Web site at `www.nyaa-starfest.com`, emailing Tony Ward at `tonyward@home.com` calling the Starfest information line at (416) 221-7375, or writing Andreas Gada, 26 Chryessa Ave., Toronto, Ontario, Canada, M6N 4T5.

ARTHUR E. COVINGTON

Arthur E. Covington — a donor of the Riche-Covington Collection to Queen's Libraries — passed away recently. In his honour, the staff of Queen's W.D. Jordan Special Collections and Music Library have put together a modest exhibit entitled "In memoriam, Arthur E. Covington, Canada's Pioneer Radio Astronomer." All members of the Queen's community are warmly invited to visit this exhibit, which includes many interesting visuals from the Collection.

Covington built the first radio telescope in Canada. His pioneering research and observations on sunspots are well recognized. Covington worked at the National Research Council of Canada and was Director of the Algonquin Radio Observatory. He also initiated the "History of Radio Science and Technology Project" at Queen's in the 1970s.

Covington assiduously collected and donated to Queen's materials documenting the history of science in his field, particularly in Canada and since World War II, complementing the McNicol Collection, which deals with the early history of telegraphy and electronic communication. The papers of Arthur L. Riche, father-in-law of Mr. Covington, are included, along with those of several other prominent researchers. Riche developed the snap action Micro Switch, which was later used in the 200-inch telescope at Mount Palomar, California.

The Riche-Covington collection also includes a number of contemporary publications, technical papers by Covington and others, an extensive photograph collection, scrapbooks, broadsides, as well as some very rare books on the history of optics and scientific method. For further details about this collection, see *A Catalogue of the Riche-Covington Collection* compiled by Barbara (de St. Remy) Teatero, 1984.

The W.D. Jordan Special Collections & Music Library is located on the 2nd Level of the Douglas Library building.

For further information, contact Vivien Taylor Head, W.D. Jordan Special Collections & Music Library Douglas Library, Tel. (613) 533-6916 or 533-2839, E-mail: `taylorv@post.queensu.ca`.

CORRECTION

[Editor's Note: In the article "Upgrading Your Campus Observatory" (February 2001, *JRASC*, pp. 8), Figure 1 was incorrectly printed. The correct figure is given here.]

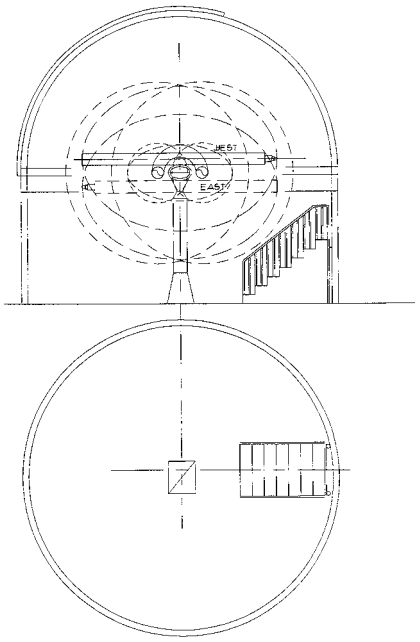


Figure 1 — The full range of motion of the telescope was analyzed and considered in the design of the new platform. Note the large footprint of the observing platform, which is a result of its height.

News Notes
En Manchettes

MIR WE GO

The *Mir* space station came back to Earth in a final blaze of glory, mimicking a fragmenting fireball as it hurtled through the Earth's atmosphere. During the early morning hours of March 23, Russian flight controllers brought to a close a remarkable 15-year space odyssey.

Approaching *Mir*. The view from Space Shuttle *Endeavor* (during mission STS-89) as it slowly edged towards a rendezvous with the *Mir* space station in January 1998 (image courtesy of NASA)

The first module of the *Mir* space station was launched in February of 1986, and prior to re-entry, the station had orbited the Earth some 86,330 times. A total of 111 spacecraft visited the station, and over 104 astronauts called the sprawling array of modules home for a grand total of 4591 days. Some 78 space walks totaling 352 hours in duration were conducted from *Mir*, and many hundreds of research experiments were conducted.

Following a series of carefully timed rocket burns, the remains of the space station were brought to rest in the Southern Pacific ocean. While the space station initially weighed-in at 143 tonnes, it is estimated that more than 1500 fragments weighing 20 kg or more will have survived the station's plunge to Earth. The debris scatter zone, however, is estimated to be some 400 km wide and possibly some 6000 km long, so while there is probably debris floating on the ocean, no concerted salvage effort is being contemplated.

A ROSE BY ANY OTHER NAME

As of March this year the Department of Astronomy at the University of Toronto was no more. But fear not, we are not seeing the demise of one of Canada's premier astronomy institutions, but rather the Department is being re-named, henceforth to be called the Department of Astronomy and Astrophysics. The new appellation, it is argued by Department Chair, Dr. P. G. Martin, better reflects the breadth of astronomical research and duties carried out by astronomers at the University.

Astronomers at the U. of T. have, in fact, changed their departmental name several times before. Original departmental astronomer C. A. Chant taught introductory astronomy classes through the Department of Astrophysics from about 1905 onwards, but it was not until 1920 that the University officially recognized the Department of Astronomy as a distinct entity from the Department of Physics. More details on the history of the Department of Astronomy and Astrophysics at the University of Toronto can be found at `www.astro.utoronto.ca/history.html`.

ODIN LAUNCHED

The *ODIN* spacecraft was successfully launched from the Svobodny rocket-range in Russia this past February 21. Named after the mythical Norse God who created the cosmos, the spacecraft and its instruments represent a collaborative project between Sweden, Canada, France, and Finland to study the distribution of water and oxygen in both deep space and the Earth's atmosphere.

During its two-year mission *ODIN* will observe comets, planets, stars, interstellar clouds and galaxies for traces of various molecules. It will also monitor variations in the Earth's ozone layer. The spacecraft will gather data with high-frequency radio receivers operating at frequencies between 500–600 GHz.

"This is one of the proudest moments of Canadian astronomy," commented Dr. Sun Kwok, of the University of Calgary and principal Canadian researcher in the *ODIN* project. The mission has been 8 years in the planning stage, and the 20% mission share contributed by Canada will involve research teams from the Universities of Waterloo, Saint Mary's, McMaster, and Saskatchewan as well as the National Research Council's Herzberg Institute of Astrophysics.

The *ODIN* spacecraft has been placed in a Sun-synchronous orbit some 600 km above the Earth's surface. In this fashion it will track along the Earth's day-night terminator with its solar panels constantly directed towards the Sun. Further images and spacecraft details are available at `www.iras.ucalgary.ca.`

CANADIAN 3D ASTRONOMICAL HERITAGE

The history and heritage of astronomy consist of more than just the astronomers and their research papers. A key, but often-overlooked, aspect of preserving the astronomical past is that of the physical equipment used by astronomers: not just

the telescopes, but the spectrometers, cameras, and observatories. Writing in the winter edition of *Cassiopeia*, the newsletter of the Canadian Astronomical Society (CASCA), Curator Dr. Randall Brooks explains that the Canada Science and Technology Museum in Ottawa is on the lookout for more Canadian astronomy hardware — literally, the three dimensional history of astronomy. Founded in 1967, the Museum already houses an impressive collection of early optical telescopes and developmental cameras and spectrometers, but there is room for more. Dr. Brooks is especially interested in obtaining early Celestron and Meade telescopes and any Canadian telescopes that might have won prizes in amateur star-party gatherings.

Dr. Brooks explains that the Museum has striven to acquire astronomy-related objects that represent major contributions and innovations by Canadians. Not only the hardware, however, but rare books and trade literature (manuals, sale brochures and astronomy catalogues) are also collected. Early photographs are also being sought if they have a clear Canadian association. Unashamedly nationalistic, the Museum seeks to both preserve and promote the astronomical advancements made by Canadian researchers and amateur astronomers over the years. Anyone with items that may be of interest to the Museum should contact Dr. Brooks at `rbrooks@nmstc.ca`.

GREAT ASTROPHOTOS WANTED

A new feature coming to the *Journal* is a regular gallery where we will feature members' astrophotographs. As well, we always have a use for photos that can be used to illustrate articles in the *Journal*.

For many of our members astrophotography is a passion. The search for the perfect shot of some faint fuzzy can consume countless frigid nights and buggy evenings — as long as the sky is clear and dark, some RASC member is out there shooting the stars and planets and other related phenomena such as aurorae and other atmospheric events.

We invite you to send us your best shots. We can handle prints, transparencies (from 35mm to 8×10 inches), and high resolution digital or scanned images in most popular formats. Your image will most likely be printed in black and white, but if you have a great colour shot, send it along as we try to print at least one colour section per year.

Contact the editors (addresses can be found on the masthead at the beginning of this magazine).

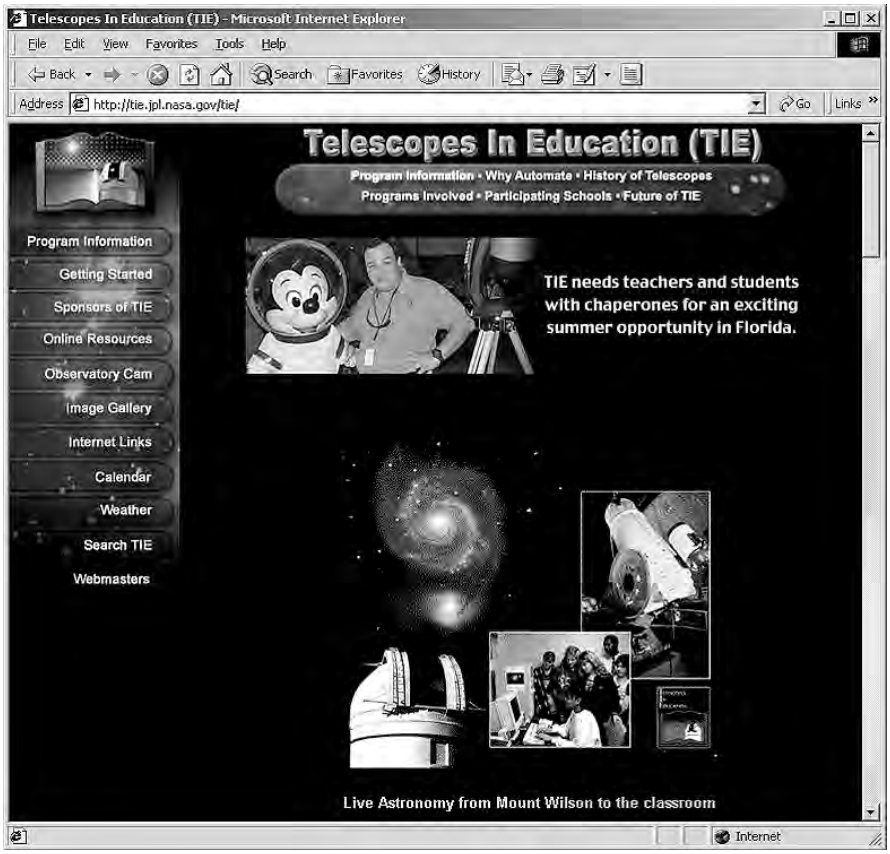
ASTRONOMY ON THE WEB — PART 2

by Les Dickson (lcdickson@sk.sympatico.ca)

Introduction

In the first part of this article (Dickson, L. C. 2001, *JRASC*, 95, 52) I presented an overview of astronomical resources available on the Web. In part 2, I want to demonstrate that the Internet can also be used to do astronomy using robotic telescopes and remotely accessible observatories.

What is a robotic telescope? At its most basic level, it is a telescope with a motorized "go-to" mount and a CCD camera, all controlled by a computer. The telescope's computer systems usually connect to the rest of the world through the Internet and use a World Wide Web (WWW) browser program as a user interface. A fully robotic telescope can decide when conditions are right and make observations of the sky by itself, working through a prioritized list of targets; an astronomer does not need to be present nor waste his or her time waiting for clear weather. Since the system does not need to be attended by a human, except for maintenance, the observatory can be located at a remote location selected for the best seeing conditions rather than for the convenience of the users. The system's computer can direct the telescope between pre-programmed targets, and do so more quickly and more consistently than human operators. That makes automated observatories ideal for repetitive tasks that may require many nights per year. Also, robotic telescopes have proven very useful for observing transient events, notably the optical afterglow of gamma ray bursts (GRBs) detected by orbiting satellites. Automated observatories are being operated by professional organizations, by talented amateurs, and by educators collaborating with the astronomical community to teach students about astronomy and science.



The home page of the Telescopes in Education project located on Mount Wilson in California.

Astronomical Research Using Automated Observatories

Billed as "the world's first remote and robotic telescope on the World Wide Web," the University of Bradford has

operated the Bradford Robotic Observatory (www.telescope.org/rti/) since November 1993. The telescope, situated on the Pennines in West Yorkshire, England, is a 46-cm Newtonian reflector with an alt-azimuth mount and a cooled CCD camera. Four personal computers interface with the telescope and its instruments. From the observatory's Web site, users can read an on-line user guide about the telescope, find technical details of the hardware and software, learn more about stars and galaxies, read weather reports, and control the telescope, all using the same interface.

The Fairborn Observatory, located in Arizona, six kilometres north of the Mexican border, is one of the largest installations of robotic telescopes on the planet. It has eight instruments installed, with four more under construction. Most are used for photometry (measuring the brightness of stars); one is used for imaging and another for spectrometry. The sizes range from 0.25-m to 0.80-m diameter, with a 2.0-m spectroscopic instrument under construction. The instruments are operated by a number of different groups, including the University of Vienna, the University of Tennessee, and two American colleges. It is best known for the first detection (November 1999) of an extra-solar planet transiting its star (HD 209458), based on observations taken by one of the 0.8-m photometric telescopes. The Web site is well organized and informative, and includes a gallery of images taken by the telescopes. It can be found at 24.1.225.36/fairborn.html.

As mentioned previously, one great advantage of automated observatories is their ability to observe transient events. Two such systems are the Robotic Optical Transient Search Experiment (ROTSE) and the Livermore Optical Transient Imaging System (LOTIS). ROTSE (www.umich.edu/~rotse/index.html) was designed and is operated by a collaboration of astrophysicists from the Los Alamos National Laboratory, Lawrence Livermore National Laboratory, and the University of Michigan. ROTSE-1 is an array of four electronic cameras mounted on a common equatorial platform. The cameras are made up of Canon EF telephoto lenses (200-mm focal length, f/1.8) in FD mounts, with Apogee Instruments AP-10 CCD cameras. The array covers a 16×16 degree field with a limiting magnitude down to 15. ROTSE-1 made the first optical observation of a GRB on January 23, 1999. The burst was first detected by the Burst and Transient Source Experiment (BATSE), a NASA instrument onboard the orbiting Compton Gamma Ray Observatory. An alert was sent out over the Internet, and ROTSE-1 was immediately pointed at the source. It was able to start observing the optical afterglow 22 seconds after it had begun. ROTSE is being expanded with the addition of ROTSE-2, a set of twin 0.45-metre aperture, f/1.9 telescopes to be operated in stereo mode. The pair of instruments will cover a 2×2 degree field with a limiting magnitude of about 18. LOTIS (hubcap.clemson.edu/~ggwilli/LOTIS/) also uses a 2×2 array of the same Canon telephoto lenses as ROTSE. In addition to observing GRBs, LOTIS also observes other transient objects such as supernovae as well as monitors long-period and short-period stellar variability. LOTIS will be expanded with the addition of a 0.6-m Boller and Chivens f/3.5 reflecting telescope that is being modified for automatic operation.

The University of California at Berkeley operates two automated facilities under the Berkeley Automatic Imaging Telescopes (BAIT) program (astron.berkeley.edu/~bait/). One facility is the Leuschner Berkeley Automated Telescopes at the Leuschner Observatory. Used until 1994 for monitoring transient objects and conducting supernova searches, the facility, which has 0.76-m and 0.5-m reflecting telescopes, is now used by students in the Department of Astronomy at Berkeley. The Katzman Automatic Imaging Telescope (KAIT) is a robotic 0.76-m telescope dedicated to searching for supernovae and monitoring celestial objects. It is located at the Lick Observatory just east of San Jose, California. A collaboration between KAIT and the Tenagra Observatories, called LOTOSS for Lick Observatory and Tenagra Observatories Supernovae Searches, has detected over 100 supernovae using their automated telescopes.

Amateur-Built Robotic Telescopes

While most robotic telescopes are built and operated by professionals, amateurs can get into the act. An example is the Hanna City Robotic Observatory, operated by Jerry Gunn and Chuck Lamb of the Peoria Astronomical Society (www.mtco.com/~jgunn/#The Hanna City Robotic). The observatory uses a Meade 8-inch LX-200 f/6.3 telescope equipped with an SBIG ST-7 CCD camera and CFW-8 filter wheel. The entire observatory, including all mechanical, electronic and optical components, is housed in a box approximately 1.3-m square and 1.5-m tall. A motor opens the lid of the box for observing. The Web site gives a great deal of detail on how the observatory was designed and built, and shows just how much can be accomplished with relatively few resources. The small remote observatory clearly demonstrates that with some creative thinking, small groups of amateur astronomers, and even cash-strapped university astronomy departments, can try remote astronomy without breaking the bank.

An amateur site with a difference is the Eyes on the Skies Robotic Solar Telescope, built and run by Mike Rushford of the Tri-Valley Stargazers at Livermore, California (sunmil1.uml.edu/eyes/). The 76-mm refractor uses a 51-mm negative lens as a Barlow to increase the focal ratio to f/30. The objective is made of RG620 glass and the negative lens is made of BK7 glass. Sunlight is filtered with a Day Star H-Alpha filter at 656.3 ± 0.06 nm. A server in Mike's home digitizes the 245×249 CCD chip output at 64 levels of gray and provides the telescope with a Web interface. The telescope's optical tube, motor driven mount, electronics, and software were all custom-made by Mike. A program called Xephem, running under the Linux operating system, is used to track and point the telescope. During the day, if the weather is cooperative, one can obtain real-time images of the Sun. If not, the site has many archived images and movies of sunspots and flares to view,

and numerous useful links to sites with information about the Sun, solar observing, observatories, and other astronomy- and science-related sites.

Robotic Telescopes in Education

One of the best educational sites showcasing how robotic telescopes can be used to teach astronomy and science is Telescopes in Education at `tie.jpl.nasa.gov/tie/index.html`. This program, run by the Jet Propulsion Laboratory (JPL) of NASA, has received numerous awards, including the 1996 Rolex Award and the Clifford W. Holmes Award for Innovative Design. Using a 0.6-m reflecting telescope located at the Mount Wilson Observatory, and The Sky: Remote Astronomy Software loaded onto a school's desktop computer, students can book time on the telescope any time in the evenings, and can arrange for long-term studies and repetitive observations. Through the program, students can improve analytical skills and computer literacy, as well as learn about astronomy and mathematics. The site makes available a wealth of information, including on-line versions of John Dobson's classic description of how to build a Dobsonian telescope for sidewalk astronomy.

The Harvard-Smithsonian Centre for Astrophysics runs an educational astronomy site called the Micro Observatory Online Telescope, found at `mo-www.harvard.edu/MicroObservatory/`. The project, sponsored by the American National Science Foundation, Eastman Kodak, and Apple Computer, was designed to give students a chance to use remote telescopes in collaborative research projects with other students and research scientists. Each of the custom-designed Maksutov reflecting telescopes uses a 0.15-m spherical main mirror and has an effective focal length of 560 mm. Kodak supplied the CCD cameras with 768×512 pixel (9×9 μm) imaging chips. The five automated scopes in the network are located in Cambridge (Massachusetts), Arizona, Hawaii, and Australia. Enrolment and use are free, but priority is given to teachers and other educators.

For more information on robotic telescopes, you can consult the Astroweb site at `simbad.u-strasbg.fr/cgi-bin/search-master?robotic`, the Robotic Telescope links page at the Bradford Robotic Observatory site (`www.eia.brad.ac.uk/rti/automated.html`), or the links pages on many of the automated observatory sites mentioned above.

Les Dickson is the president of the Saskatoon Centre of the RASC and is co-chair of the Saskatchewan Summer Star Party. He holds a Doctorate in Chemistry, and is a Research Scientist working for a Federal Government agency.

Adventures in

DEEP SKY ASTROPHOTOGRAPHY

by Douglas Stuart, Thunder Bay Centre (doug@lakehead.net)

I'm going to share with you a technique for achieving spectacular results in astrophotography. The only equipment required is a camera, a tripod and some film. Let me give you the background of how I learned this method.

IN THE LAB

I was taking a course in photography at the local university. One evening while working on an assignment in the darkroom, I removed the film from its container of developing fluid and was surprised to find that the negatives were very dark. It turned out that the developing fluid was at too high a temperature and the required time to process the film had been greatly reduced. The film had been "over-developed." That was my first experience with push processing film.

The chart showing the developing times at various temperatures indicated that the black and white film we were using, Kodak T-MAX, could be used at speeds of up to ISO 3200. The pieces were falling into place. Now all I needed was a dark sky site to take the pictures.

IN THE WILD

I drove down countryside roads looking for an ideal spot. The best location was far from ideal. It was near an unguarded railway crossing on the side of a lonely country road. Every once in a while wolves howled nearby and something large roamed among the trees.

About a dozen 30-second exposures on T-MAX 3200 film were taken, using a 50-mm lens at f/1.8 and a tripod. The photographs were a panorama along the Milky Way from Aquila to Auriga.

Figure 1 — The Northern Cross part of Cygnus provides us with the brightest section of the Milky Way in the Northern Hemisphere.

Figure 2 — The W asterism in Cassiopeia, and to the right the Andromeda Galaxy (M31). The Double Cluster (NGC 884/869) is at the bottom.

LOUSY LAB

I thought it would be easier to use a photo finisher to develop the negatives and make prints. The results were impressive. The Milky Way was very prominent along the whole length of the panorama. The negatives, however, had "disappeared," according to the photo lab!

TRY AGAIN!

My next roll of film would be the best. I found a darker sky site further out in the countryside, at the end of a dead end road. The only wildlife was some unfriendly guard dogs. The horizons were unobstructed from 90 degrees (due east) to 300 degrees (WNW).

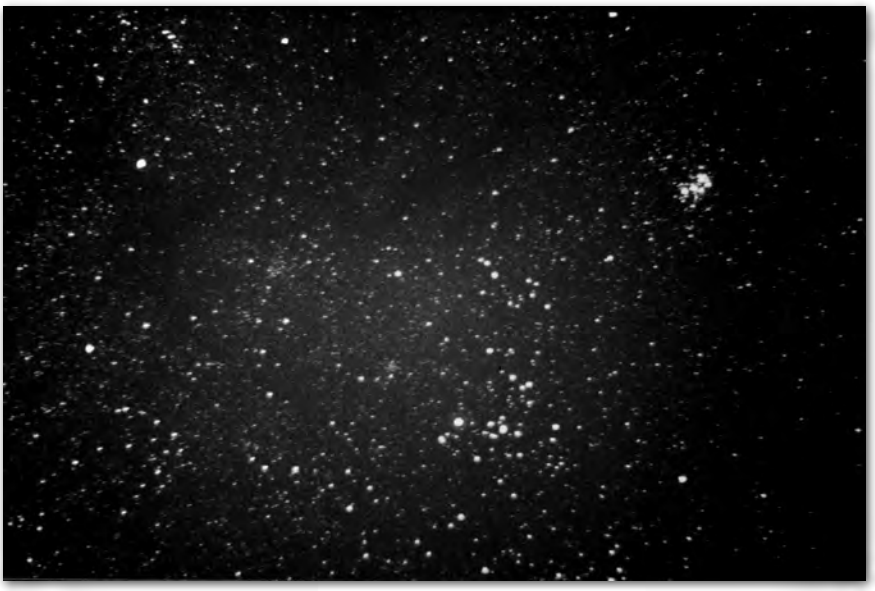


Figure 3 — Taurus with the Hyades and Pleiades star clusters, not part of the panorama, but worth a look. Note the dust clouds obscuring the background stars at the top.

Figure 4 — The Teapot asterism in Sagittarius, plus globular and open clusters, emission nebulae and the centre of the Galaxy. This constellation has it all!

The camera was loaded with T-MAX 3200 film once again, with the addition of two Ziplock bags taped to the camera. The bags were full of ice cubes to cool the film and thus make it more sensitive to light. A cable release was used this time, and a red filtered flashlight illuminated my watch for precise timing of each 30-second exposure. With the lens wide open at f/1.8 I began my new and improved panorama.

NO TRESPASSING!

It was late evening and with the Milky Way from Auriga in the NE to Cygnus overhead photographed, I was interrupted by the high beams from a truck, probably the owner of the property. The owner stopped his truck and looked around. No doubt he saw my car parked near the entrance to his property. He gave up looking and left the area. I quickly finished shooting Cygnus and beyond Aquila down to Sagittarius and the horizon.

LET'S BE AMBITIOUS

Since it was September, there was the possibility of extending the panorama much further by returning to the same site, this time just before morning twilight. I could re-photograph Auriga while it was directly overhead and go beyond into Orion.

After a four-week wait for a clear night with low humidity and no Moon, the project continued.

THE FINAL STEP

With no interruptions this time I was able to photograph Auriga through to Canis Major. I took the film to the most reputable photo lab in Thunder Bay. I told them "I shot the film at 3200. Push it to 12800." This would make the film grainy in appearance, but I believed that since the subject matter was a collection of pinpoint light sources (stars), it wouldn't matter.

The prints really were amazing, much better than my first attempt! So good in fact, I put my knowledge of black and white film printing to use and made my own 8×10 prints of the panorama. Here are the best of the best.

Figure 5 — The constellation Auriga. Look closely and you can see M36, M37 and M38.

Figure 6 — The northern part of Cygnus, with Deneb and the North America Nebula (NGC 7000) at bottom. The constellation Lacerta is at top left.

Figure 7 — The constellation Vulpecula with the Dumbbell Nebula (M27) and the Coathanger Cluster at bottom. Note the meteor trail at bottom right.

Doug Stuart was recently elected President of the Thunder Bay Centre, after two years as Vice President and four years as Media Representative. He has completed the Messier list three times and the NGC 110 list 2 ½ times with three different instruments: 10 × 50 binoculars, a 4-inch Schmidt-Cassegrain and a 10-inch Dobsonian. He has observed 36 Deep-Sky Challenge objects with his 10-inch.

A Lamplighter Moment:[1]

Hunting for the *Green Flash*

by David Turner (turner@ap.stmarys.ca)

The first three years of operation of the University of Toronto's Southern Observatory (UTSO) on Cerro Las Campanas in Chile coincided with my last three years of graduate study at the University of Western Ontario. I recall being fascinated at the time by the wondrous tales of the site that were related by those who had visited it. I remember vividly, for example, the marvelous story René Racine told at a meeting of the RASC London Centre. While observing, he was distracted by a faint red glow inside the telescope dome. The glow was eventually discovered to originate from the light of Mars shining through the dome opening! On another occasion, Chris Smith, at the time the University of Toronto's Resident Astronomer at the Southern Observatory, visited the Western campus to see a friend in our graduate program. Chris described a variety of other marvels of the site: incredibly faint stellar limits for viewing with the unaided eye, a relative humidity so low that towels were almost unnecessary after a shower, and green flash sightings so commonplace that they occurred at every sunset. It was the last claim that caught my interest. Up until then I had never witnessed the green flash, although I had searched for the phenomenon on many occasions at our family cottage on Georgian Bay — watching in vain for a green pinpoint of light to appear as the Sun set below the waters of the Bay.

I completed graduate studies at Western in September 1974, and immediately began postdoctoral studies with Bob Garrison at the University of Toronto. I had been at Toronto only a month before I made my first trip to Chile for an observing run at the UTSO. It was a wonderful opportunity to experience all of the marvels of the site first-hand, although I recall that the many clear nights of observing often did not leave much time for idle occupations. I did search for the green flash faithfully at every clear sunset, since I was still fascinated with seeing one for the first time. As it turned out, the green flash was not as common an occurrence at the site as I had been led to believe. The western horizon from Cerro Las Campanas looks toward a coastal range of mountains, over which there is an almost continuous mantle of clouds rolling inland from the Pacific Ocean at certain times of the year. During my first visit to the UTSO, the mantle of clouds over the coastal mountains never disappeared. Las Campanas itself, as well as the desert to the west, remained remarkably clear, but each day the Sun set into the cloudbank on the horizon, without a green flash. The disk of the Sun as it set into the clouds gradually diffused into a series of orange "droplets," none of which produced a green flash as it disappeared. I was very disappointed.

Eventually it occurred to me that perhaps I should try to observe the green flash at sunrise rather than sunset. After all, the eastern horizon was always clear, even if it was "higher" than the western horizon. To the east of Las Campanas are the Andes Mountains, most of which reach much greater altitudes than Cerro Las Campanas. From the mountaintop, the eastern horizon is therefore noticeably a few degrees higher than a sea-level horizon, depending upon the exact direction being viewed and whether or not there is a tall mountain along the line of sight.

It was towards the end of my observing run that I put the plan into action. Foregoing much-needed sleep — I am not a daytime sleeper, and on observing runs rarely manage to sleep

[1] Dedicated to the memory of Father Lucian Kemble (1922–1999), *a.k.a.* "Lamplighter," who touched the lives of countless members of the RASC through his love for all aspects of observing. A "Lamplighter moment" is simply an occasion where, through careful observation of the mundane, one unexpectedly discovers something profound, something achieved by Lucian Kemble fairly regularly during his lifetime. This section is a regular part of the *Journal* devoted to guest articles by authors describing their Lamplighter moments.

much past noon — I decided to stay up after a tiring night of observing to search for the "morning green flash." I watched for the dawn twilight skies to brighten, strolled northward along the ridge of Las Campanas to a location from which the Sun appeared to rise in a valley between two Andean peaks, and then patiently waited for the Sun to come up. While waiting, I noticed that the sky transparency was remarkably good. (During a later trip I learned that dust settled overnight at Las Campanas, as the almost invisible clouds of particulate matter that were raised during the day by an open pit mine to the west of the observatory sank to levels below the top of the mountain.)

Waiting for sunrise requires a lot of patience, particularly when one is extremely tired. I focussed my complete attention on the eastern horizon, and tried to judge from the relative brightness of the sky exactly where the Sun would appear along the horizon. I adjusted my viewing point several steps to the north or south of my present location, depending upon where I thought the best "rising point" would lie. In my mind I could already picture the brief flash of green that I expected to see, followed by the appearance of the Sun's upper disk on the horizon.

Then it happened. Just as I was beginning to think that the sky would brighten forever without the appearance of the Sun, suddenly an extremely bright *blue* flash of light appeared on the horizon. It was followed in an instant by the appearance of the bright whitish disk of the Sun's upper limb slowly gaining altitude above the mountain valley from which it had risen. I was stunned, but only for an instant. As my mind grappled with the problem, I suddenly realized that atmospheric transparency was the key. Because of the high transparency at the site (particularly in the morning) and the unusually high altitude of the eastern Andean horizon, there must be significantly less atmospheric extinction associated with viewing sunrise on Las Campanas than with viewing sunset. Since the blue light of the Sun's spectrum was not significantly scattered out of my sight line by the Earth's atmosphere, I was not relegated to seeing only the "green" portion of extinction-dominated sunlight reaching me along the horizon. In effect, I had just viewed the green flash phenomenon in its purest form — with minimal influence from atmospheric extinction. Wow!

As I plodded back towards the observers' residence for a few hours of sleep, it suddenly struck me: I had *still* not observed the Green Flash!

David Turner, who recently "retired" as the editor of the Journal, *is a professor of Astronomy and Physics at Saint Mary's University. When he is not instructing students or being involved in research on open clusters and variable stars, he enjoys the beauty of many different celestial phenomena. He has still not observed the green flash.*

Mosaic CCD Astrophotography

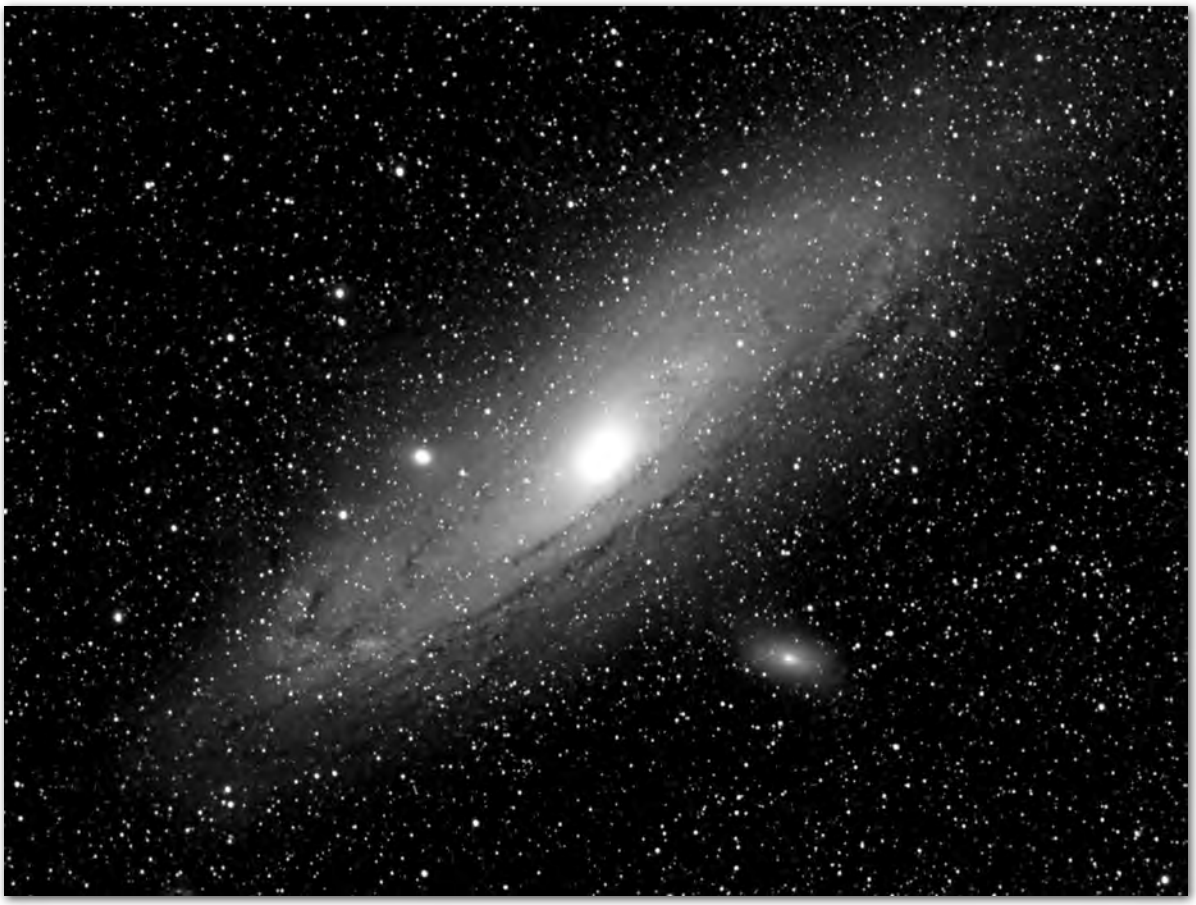
Images by Jan Wisniewski, Kingston Centre (jwisn@lycos.co.uk)
(text prepared by Dave Lane)

Included here are a selection of mosaic CCD images taken by Jan Wisniewski from both Sooke, BC and Harrowsmith, Ontario. For all images, he used his Cookbook 245 CCD camera and Celestron Ultima 8-inch Schmidt-Cassegrain telescope.

Traditionally CCD cameras, due to their small imaging area, are not associated with the imaging of large astronomical objects, at least while also retaining high-resolution results. Jan has developed and perfected a technique of imaging large fields by taking many overlapping single frames and combining these frames into a mosaic later using computer software.

Hopefully Jan will share his tips and techniques with readers of the *Journal* in a future issue. In the meantime, you can learn of his work and enjoy all of his images at his website (`jwisn.topcities.com` or `jwisn.freeyellow.com`).

North America and Pelican Nebulae in Cygnus — a mosaic composed of 72 tiles (each three exposures of 60 seconds) taken on September 2, September 7, and October 2, 1999 from Sooke, BC.



Andromeda Galaxy (M31) — a mosaic composed of 25 tiles. Each tile corresponds to a stack of 5 exposures (60 seconds each) taken on September 6, 7 and 11, 1999 from Sooke, BC.

IC1805 Complex in Cassiopeia — a mosaic composed of 24 tiles. Each tile corresponds to a stack of 5 exposures (60 seconds each) taken on October 9, 1999 from Sooke, BC.

Rosette Nebula (NGC2337-39) in Monoceros — a mosaic composed of 12 tiles. Each tile corresponds to a stack of 5 exposures (60 seconds each) taken on October 20, 1999 from Sooke, BC.

Cocoon Nebula (IC 5146) and Dark Nebula B168 in Cygnus — a mosaic composed of 12 tiles. Each tile corresponds to a stack of 4 or 5 exposures (60 seconds each) taken on October 19, 2000 from Harrowsmith, Ontario.

Veil Nebula (NGC 6960, 6979, 6974, 6992, 6995, and IC 1340) in Cygnus — a mosaic composed of 48 tiles.
Each tile corresponds to a stack of 3 exposures (60 seconds each) taken on October 15, 16 and 17, 1999 from Sooke, BC.

Triangulum Galaxy (M33) — a mosaic of four tiles, each comprised of four 4-minute long white light images (with infrared blocking filter). The images were taken from Sooke, BC on January 29, 2000.

IC 1396 Complex in Cepheus — a mosaic composed of 43 tiles. Each tile corresponds to a stack of 5 exposures (60 seconds each) taken on September 13 and 14, 1999 from Sooke, BC.

California Nebula (NGC1499) in Perseus — a mosaic composed of 21 tiles. Each tile corresponds to a stack of 5 exposures (60 seconds each) taken on September 18, 1999 from Sooke, BC.

Comet Tales:
Sir William Huggins and Jean Louis Pons

by David M. F. Chapman (dave.chapman@ns.sympatico.ca)

In this issue, we have a couple of comet anniversaries to celebrate. Two hundred years ago, one of the most successful comet hunters of all time, Jean-Louis Pons, discovered the first of 26 comets that bear his name. More recently, Sir William Huggins photographed the first spectrum of a comet, 120 years ago. Here are their stories…

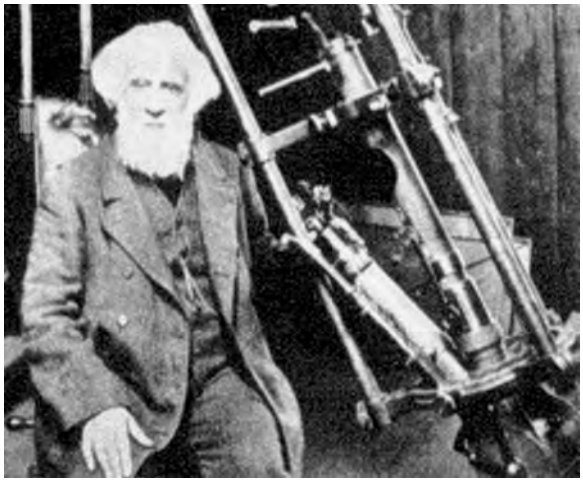
Jean Louis Pons (1761-1831)

Jean-Louis Pons was born on Christmas Eve, 1761, in Peyre, France. His family was poor and he had a limited education; certainly there was no expectation that he would become an accomplished astronomer. At the age of 28, he was hired as the custodian of the observatory at Marseilles. He quickly learned how to use the telescopes and soon was making observations of his own. Using a wide-field instrument, he discovered his first comet on the night of July 11, 1801. By coincidence, Messier found the same comet — his last — just one day later. There are 26 comets with the name Pons and he may have discovered as many as 11 more (David Levy, *The Quest for Comets*, Plenum Press, 1994, page 53). Pons was promoted to the level of assistant astronomer in 1813, and eventually became director of observatories in the Italian cities of Lucca and Florence.

The short-period comet (3.3 years) we now know as Encke's Comet was actually discovered by Pons (as well as Pierre Méchain and Caroline Herschel). Encke followed up Pons's suggestion that this comet discovery was in fact a re-discovery of an earlier find. Encke reduced the positional data to compute the orbital elements of the comet and predicted its return in 1822. This prediction was verified, although the comet was only seen that year from the Southern Hemisphere. Interestingly, Encke always called the comet "Pons's Comet." This comet has been observed on every subsequent return, save one.

Pons was honoured by the Académie des Sciences (Paris), who awarded him the Lalande Prize (shared) three times. The Royal Astronomical Society (London) awarded Pons a silver medal. There is also a lunar crater named after him.

Pons's remarkable string of comet discoveries was curtailed by failing eyesight. In 1831 he gave up observing and he died shortly thereafter in Florence. During the period 1801–1831, he had been responsible for three out of every four comet discoveries!



William Huggins was an independently wealthy British amateur astronomer who in 1855 used the family fortune to build an observatory in Upper Tulse Hill.

Sir William Huggins (1824–1910)

William Huggins was an independently wealthy British amateur astronomer who in 1855 used the family fortune to build an observatory in Upper Tulse Hill (near London, his birthplace). Inspired by the findings of the German chemist Robert Bunsen (of Bunsen burner fame), he became interested in comparing the optical spectra of stars and other heavenly bodies to the spectra of laboratory chemicals, in order to determine the composition of the far-away objects. In this way, he was able to tell the difference between glowing gas clouds such as the Great Orion Nebula and extra-galactic nebulae such as the Andromeda Galaxy, whose spectrum is star-like.

On June 24, 1881, Huggins made a one-hour spectrogam of the head of comet 1881 III Tebbutt. He observed the typical dark Fraunhofer absorption lines of the continuous solar spectrum (due to light reflected from the cometary dust) plus some emission lines associated with carbon and cyanogen (CN).

In 1910, the much-heralded return of Halley's Comet took a bizarre turn when it was realized that the Earth would pass through the tail of the comet on May 18 and 19. Following the spectroscopic discoveries of Huggins and others, there was widespread fear that everyone in the world would be poisoned by gas in the comet tail. (Cyanogen is a colourless and poisonous gas that burns with a violet flame, and whose odour is reminiscent of peaches.) Enterprising vendors offered "comet pills" to the gullible public, to ward off the dangers. Of course, nothing happened, but little did anyone know how insubstantial a comet tail is, in fact.

Huggins also pioneered the use of spectral analysis of starlight to determine the radial speed of stars by measuring the Doppler-Fizeau shift of the standard

lines in the spectrum. In 1868 he measured the "red shift" of Sirius. Later, Hubble and others applied this technique to galaxies to establish the rate of expansion of the universe.

Huggins was knighted in 1897. He received multiple honours from the National Academy of Sciences (US), the Académie des Sciences (Paris), the Royal Astronomical Society, and the Royal Society. From 1900 to 1906, he was President of the Royal Society. Not only is a lunar crater named after him, a Martian crater also carries his name.

David Chapman is a Life Member of the RASC and a past President of the Halifax Centre. Visit his astronomy page at www3.ns.sympatico.ca/dave.chapman/astronomy_page.

Second Light

Cosmic Indigestion

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

One of the most exciting developments in astronomy during the 1990s was the discovery of planets around nearby stars. About one percent of nearby solar-type stars are known to have orbiting companions, based upon very precise measurements of regular variations in the radial velocities of the stars. The first extra-solar planet discovered (not having a pulsar parent) — by Mayor and Queloz of the Geneva Observatory (see November 23, 1995 issue of *Nature*) — was orbiting the star 51 Pegasi at a distance of only 8 million kilometres. Numerous other planets discovered since then also orbit their parent stars at distances less than that between the Earth and the Sun. The small planet-star separation raised the possibility that some planets might get so close that their parent stars could swallow them. Evidence for this has now been seen by Garik Israelian (of the Instituto de Astrofisica de Canarias in Spain) and collaborators (see May 10, 2001 issue of *Nature*).

According to what we think we understand about planet formation, it seems impossible to form Jupiter-like planets closer to a star than at least a few astronomical units (an AU is the mean separation between the Sun and the Earth), yet that is exactly what we see in the sky.

" About one percent of nearby solar-type stars are known to have orbiting companions, based upon very precise measurements of regular variations in the radial velocities of the stars."

Two general schemes have been proposed to move giant planets from where they plausibly could form — at distances like Jupiter's orbit — to where they are seen, closer even than Mercury is to the Sun. In the first theory, the forming planet interacts gravitationally with the accretion disk of dust and gas out of which the star and planets form. The disk probably survives for about ten million years or so, during which time a forming Jupiter-like planet could migrate inwards. The migration could halt close to the star if the disk has dissipated, or the planet could continue inwards to merge with the young star itself. The second mechanism involves the formation of multiple large planets like Jupiter, which gravitationally "scatter" like breaking pool balls hit by the cue ball. For example, if there are three planets, one could be ejected completely from the system, one sent down close to the star — or even into it — and one might survive in a very eccentric orbit.

Which brings us to the search for the telltale signs of a star swallowing a planet. Stars, of course, consist almost entirely of hydrogen and helium; in the Sun, only about two percent of the mass comes from all the other elements combined. But each element has a fingerprint that is almost unique — its emission spectrum. By searching for the signatures of the elements in the spectrum of a star, it is possible to determine just how much of each element is in the star's atmosphere. If a star has a lot more "metals" — to an astronomer, any element heavier than helium — than it should, given its age and location in the Galaxy, then it is plausible that those elements came from a planet absorbed by the star. Even a small, solid, Earth-like planet could produce an observable elemental signature. This is the approach taken by Guillermo Gonzalez and his collaborators of the University of Washington (see January 2001 issue of

the *Astronomical Journal*). Gonzalez' team has undertaken a systematic program to investigate the abundances of metals in stars known to have planets orbiting them; they find that these stars on average have higher "metallicities" than other solar-type stars.

While suggestive, this approach is subject to various uncertainties associated with selecting the samples of stars. For example, it is well known that the metallicity of the Galaxy increases with time, so stars of subsequent generations will in general have more metals than the Sun. While it is possible to estimate ages of the stars, the uncertainties are so large that all one can say (so far) is that the result is consistent with the hypothesis that stars with planets may have eaten another planet or two. There are other problems as well.

In principle, a more definitive approach is to look for an element or isotope that should not be in a normal star, but would be present in a star that has swallowed a planet. Israelian and his colleagues have taken this approach, using a light isotope of lithium as their tracer. Lithium is fairly easily destroyed ("burned") in nuclear reactions inside a star, with the ^{6}Li isotope being particularly easily burned. When a star is young, it is almost entirely convective, meaning that the gas bubbles like a rapidly boiling pot. This cycles all of the gas in the star down towards the centre, where the lithium can be burned, so there should be essentially zero ^{6}Li in a normal star more than about 50 million years old. But a Jupiter-like planet does not get hot enough in its centre to burn lithium, and of course a solid planet like the Earth would not burn any. A star that settles down to being a well-behaved main-sequence star (not fully convective) and then absorbs a planet will therefore have ^{6}Li in its spectrum. This is what Israelian and his colleagues have found — ^{6}Li in the spectrum of the star HD 82943. They argue that the most plausible explanation for its presence in this star is that HD 82943 swallowed a planet.

"If a star has a lot more "metals" — to an astronomer, any element heavier than helium — than it should, given its age and location in the Galaxy, then it is plausible that those elements came from a planet absorbed by the star."

Because a planet that migrates inwards will do so on the same kind of timescale over which the star's convective zone shrinks, Israelian and his colleagues further argue that their result implies that the absorbed planet was gravitationally scattered into the star, rather than migrating. This also appears to be consistent with the high eccentricity of the planet now orbiting HD 82943. The issue here is that if the planet is absorbed as a result of migration, it will do so while the young star is still fully convective, so that some fraction of the lithium from the planet will be destroyed, making the observational signature weaker.

Further evidence of the digestive make-up of stars may bring more solid evidence to light.

Dr. 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.*

OBSERVER'S HANDBOOK 2001 ERRATA

Grazing Lunar Occultation Table Errata

The table of grazing lunar occultation predictions on page 154 of the *Observer's Handbook 2001* does not correspond exactly to the tracks in the maps on the following pages. Three tracks are present in the maps but not in the table, and therefore the numbering of the tracks in the table does not correspond to the numbering in the maps.

If you use this section of the *Handbook*, you should obtain a corrected table from the RASC web site. Go to:

`http://www.rasc.ca/pubs/OHpage154.htm`

to obtain a pdf file with a corrected table or a corrected table in text format.

(due to an error by the *Journal* staff, this errata should have appeared in the April issue. We apologize for the delay in publication).

Research Papers
Articles de recherche

CANADIAN THESIS ABSTRACTS

Compiled by Melvin Blake (blake@aries.phys.yorku.ca)

A Photometric Investigation of Low-Mass Stars in M67
by Gordon Mosher (gmosher@aries.phys.yorku.ca)
York University, MSc.

The study of low-mass stars is still in its adolescence because such stars are challenging to investigate due to their low effective temperatures ($2000 \leq T_{eff} \leq 4000$ K) and intrinsic faintness. Yet their study is important since they are the most common stellar objects in the Milky Way Galaxy.

Recently, model atmospheres for cool, low-mass stars have emerged, principally by Allard *et al.* (1999). Resulting synthetic spectra will be a useful diagnostic for the surface temperature, metal abundance (metallicity) and surface gravity of these stars. However, they have not been sufficiently tested to date. Krawchuk (1997) developed a method to test aspects of these models using broad-band photometry and showed that the models are reasonably consistent with observations under the assumption that the surface gravity parameter, *log g*, is 5.0.

It is the purpose of this work to explore the sensitivity of the models to changes in *log g* by comparing synthetic photometry to V, R, I, and J photometry of M67, an old open cluster with solar metallicity.

It was found that the assumption that *log g* = 5.0 is appropriate for the reddest stars, as expected. It was also found that although the synthetic spectra provide a valuable diagnostic for temperature and metallicity, they are significantly less useful for metallicities near solar. It is also found that metallicities for individual stars derived from different colour-colour diagrams are consistent with one another. Recommendations for further tests are made, including observations of younger, more metal-poor open clusters.

Society News/Nouvelles de la société

Submitted by Kim Hay, National Secretary (kimhay@kingston.net)

The Spring Equinox has come and gone and I think we are all hoping that the snow and clouds will disappear. It has been a long haul since some of us observed the solar eclipse, let alone clear skies, stars, and planets.

National Council Updates

A National Council meeting was held in Toronto on March 10, 2001, with good representation from most centres. The Council agreed to award several Messier Certificates and Finest NGC Objects Certificates. Congratulations to Joyce Carley, Robert R. Chapman, and Dave Halliday, all of the Toronto Centre, and to Michael Hanes of the London Centre for completing their observations of the 110 objects in the Messier List. Congratulations to Paul Markov of the Toronto Centre for completing the requirements of the Finest NGC Objects.

There have also been nominations for award recipients for all four major RASC awards this year (Service Award, Chant Medal, Simon Newcomb Award, and the Ken Chilton prize). The awards will be handed out at the General Assembly. Citations for these awards will appear in the next issue of the *Journal*. For more information on these awards, please visit the RASC Website at www.rasc.ca.

Upcoming Events

Now on the flip side, we can always think along the lines of summer, pesky bugs, clear skies and observing, especially without looking like the Michelin Man. There are many upcoming events to plan our summer vacations and observing sessions around. At the bottom of this page is a listing of upcoming events and Star Parties.

Congratulations

Doug George, member of the Ottawa Centre and past-president of the RASC, has won the 2001 Medal for Engineering Excellence from "Professional Engineers Ontario," the society which "regulates the profession while enhancing engineering culture and practice." The prize is awarded each year for overall excellence in the practice of engineering, where the innovative application of engineering knowledge and principles has solved a unique problem, led to advanced products, or produced above-average results.

An excerpt from the award citation states "Douglas George demonstrates continuous commitment in many aspects of engineering and the sciences as an innovator, leader, administrator, and communicator. He is a gifted inventor with a remarkably astute understanding of fundamental engineering principles, who has pursued his hobby of astronomy until he has been able to incorporate it into his career. Truly passionate about the study of the universe, he shares his enthusiasm with others whenever possible. In addition to teaching a course on astronomy, he has appeared many times on radio, television, and print media. In 1989 he co-discovered Comet Skorichenko-George. Since then he has co-discovered seven supernovae in distant galaxies and is also credited with co-producing one of the best time lapse movies of a comet.

George has been an active member of the Royal Astronomical Society of Canada for many years. As president from 1996 to 1998, he helped increase membership levels by 50 per cent in three years. He is credited with transforming the RASC by improving its service to members and the public, enhancing its publications, and streamlining its operations."

To read the full citation see www.peo.on.ca/Communications/Awards/awards_2001winners.htm

DATE	EVENT	PLACE	CONTACT INFO
June 29-July 1	General Assembly 2001	London, Ontario	www.rasc.ca
July 20-22	North Bay Astronomy Club	Powassan, Ontario	Contact Merlin at 1-705-472-1182 Tom Ouellette at 1-705-474-7666 galaxy@efni.com
July 28-31	Island Star Party 2001	Victoria, BC	Starfinders.cvnet.net
Aug 16-19	Starfest	Mt. Forest, ON	www.nyaa-starfest.com/
Aug 17-18	Stellafane Star Party	Springfield,Vermont	www.stellafane.com/
Aug 17-19	Nova East 2001	Smiley's Provincial Park, Nova Scotia	www.halifax.rasc.ca/ne/
Aug 18-26	Mt. Kobau Star Party	Kelowna, BC	www.bcinternet.com/~mksp
Aug 21-25	Great Manitou Star Party	Gordon's Park & Carter Bay Resort, Manitoulin Island, Ont.	www.manitoulin-link.com/starparty

EXTENDING OUR SOCIETY

Our society is national in name, and we earnestly desire to make it national in character. In 1905, the Ontario Government encouraged us greatly by substantially increasing our grant; and during 1906 upon showing what we had already done and explaining our high aims, the Dominion Government generously recognised our work by giving us a grant of $1000 a year. In carrying out our plans for extension, we decided to issue, first, a *Canadian Astronomical Handbook*, containing astronomical predictions and other information, arranged in a form especially suited to the needs of Canadian observers; second, a bi-monthly periodical, which we propose shall contain papers presented to the Society, minutes of our meeting with some of the discussions, reviews of current scientific articles and of new books, and other matters of interest. We think that a daily companion, carried in the pocket or placed on the desk, such as we hope our *Handbook* will prove to be, and a periodical visitor bringing up-to-date information on astronomical effort throughout our Country and the world at large, should attract to our ranks, intelligent students of natural phenomena from every part of Canada.

The *Handbook* is now ready for distribution. It was intended to send it to the members before the New Year, and the failure to do so cannot be charged against the editor. The bi-monthly—which we hope will become a monthly before long—will be called *The Journal of the Royal Astronomical Society of Canada*, and the first number will be ready early in February. All the publication will be sent free to all members, and we are looking for a great increase of membership during 1907.

The annual fee for membership is $2.00; and to encourage the information of *Sections* of the Society at various centres, the Council proposed, and the Society sanctioned the suggestion, that when a local organisation has been satisfactorily accomplished, one half of the fees of the members of that *Section* be remitted to meet local expenses.

In December last, a Section was organised in Ottawa on these lines, and a revision of our constitution is now under consideration in order to provide for local autonomy in the Sections, and at the same time perfect union of interests in the Society as a whole. The Ottawa Section will undoubtedly give a highly creditable account of itself.

Soon, we hope to have similar organisations in Montreal, Winnipeg and other places, and I trust you will not think the spectacles through which I look to be too rosy, when I say, that I see before me a long and honourable career of usefulness for our Society. The greatness of a nation does not consist in mere material bigness, or in the magnitude of its trade returns; rather must we attend to the intellectual, the moral and the spiritual attainments of the people, if we are to reach true distinction. I believe the Royal Astronomical Society of Canada, will in the coming years, be a great power in the development of the higher faculties of the Canadian people.

by C. A. Chant,
from *Journal*, Vol. 1, pp. 18–19, January-February, 1907

Another Side of Relativity — Is anyone ELSE confused??

Report on the March 10 National Council Meeting

by Robert Dick, Ottawa Centre National Representative (rdick@ccs.carleton.ca)

The RASC's National Council Meeting that was held on March 10, 2001 was to be relatively straightforward; or, so it seemed after I read the agenda and committee reports that had been e-mailed to the Centre representatives. (These reports are eventually made available to members on the RASC Web site.) As usual, there were impediments to the realization of my expectation. Beneath the misty view of the meeting's sanitized reports were currents of change. This is exactly what I like about attending these meetings. The unexpected makes the meetings exciting and entertaining on the technical and interpersonal level.

The meeting began on time Saturday morning in the posh offices of Smith and Lyons in Toronto. The venue alone is reason enough to be a Centre representative! From the 62nd floor we could see to the horizon, both towards Hamilton and across Lake Ontario towards the state of New York. There were in excess of twenty in attendance representing a good cross-section of our Society: geographically and in opinion. Indeed, our Society grew by another Centre at this meeting with the voting-in of the Prince George Centre! The RASC is now a gathering of 26 Centres across Canada with about 4,400 members. Of these, about 580 are "Unattached" or do not belong to Centres. More about these later.

Executive Secretary

Bonnie Bird (our Executive Secretary) reported on activities in the National Office. The new office software system (MPA system) is making the processing of new memberships and renewals much easier (and faster) and mailings are made within weeks instead of months! The initial cost of the system (approximately $35,000) and its maintenance cost (less than $6,000 per year) has made it possible for our two employees to handle the higher society membership and at the same time improve the service to members. When you call the National Office, "it kind of makes you feel like a somebody."

The information on the Society's Web page has resulted in a significant decrease in the request for information about our Society and membership. This decrease has not inhibited our membership from growing. An interesting statistic is the number of non-renewals. At the national level, the percentage of non-renewals is about 15%. So, with a net increase in the Society of about 10% per year, we have successfully attracted about 1000 new members in the past year.

Treasurer's Report

The Treasurer, Michael Watson, followed Bonnie. One thing you can count on at a Council Meeting: if something interesting is going to happen it will probably be in finance! After being carefully guided through the financial statements, the representatives of many Centres and the executive of the Society showed concern over the trends behind the numbers. Although the budget for 2001 contained a modest surplus, the foundation for the surplus was not very firm. After a lengthy debate in which all Centre representatives had the opportunity to voice their views it was proposed that an increase in membership fees be considered by the membership at the General Assembly in London this summer. It was a close vote! This is only the second time I have witnessed a vote that required the President to break the tie!

The argument for the proposed fee increase contained several important items:

- The revenues from the *Observer's Handbook* were beginning to show weakness, which has been anticipated for some time. With the number of software-based "Handbooks" increasing, some customers appear to prefer a computer program over a physical book. The Society's financial well-being depends on *Handbook* sales.

- The projected surplus in the 2001 budget is really just "paying back" the deficit we experienced in the previous two years (about $42,000).

- Could we not draw upon the Society's cash reserves? Yes and no. Most of this money is in special funds (about $299,000) such as the Endowment Fund and the Ruth Northcott Fund, both of which have rules defining their purpose and use. Only those reserves which are not limited by our bylaws could be used (about $82,000). It is prudent, however, to keep that asset intact for when a large expenditure is required. This was the case for our new office MPA system. We would not have been able to afford this system without that "money in the bank."

- It is expected that the cost of some services that our membership has enjoyed in the past will increase in a year or so. To maintain these services, we will require additional income.

Our membership is increasing quickly. It seems like a bit of a paradox but with every new member we lose money (or come close to it)! That is because the cost of service (mostly due to publications) is greater than the portion of the fees that go to the National Office. The last increase went a long way to closing this gap, but another increase is needed to close it.

With the increase in membership, we might need the staff in the National Office to work longer hours or we might need another part-time employee. The ramifications are obvious.

Most Centre representatives accepted

the concept of a fee increase. Several Centre representatives remarked that with the increase, membership in the RASC was "still a deal." The matter of when the fees should be increased was not so clear. It was the argument by Rajiv Gupta, our second vice-president, that I believe swayed those at the table. Change in the RASC is very slow. It takes one or two years for a fee increase to fully benefit our operations. Yet the affect of lost sales revenue is immediate. Therefore, although the vote was very close, the National Council will ask the membership to consider a fee increase. If approved it will take effect after August 31, 2001. It was proposed that the increase will result in the following fee schedule: Youth – $27.50, Regular – $44 and Life – $880.

It is crucial to note that the National Office receives only 60% of these fees. The rest remains with the Centres, so the Centres will benefit from the increase. Centres that are sensitive to fee increases and have a surcharge applied to their fees may lower their surcharges thereby protecting their members from the Centre portion of the increase. Those without a surcharge may apply a "negative surcharge" thereby reducing the net fees charged to their members.

Then, just as we thought the most contentious topic was behind us, an issue from a previous Council Meeting rose up: the decoupling of the National and Centre fees. Our bylaws dictate that 60% of the Youth and Regular fees be sent to the National Office and the remaining 40% goes to the Centres. So, even if a Centre does not need a fee increase, when the National Office raises the fees they have one anyway because of this legal link. Does it have to be this way? Last year, Centre representatives were asked to get feedback from their membership about the idea of decoupling these fees so that when the National Office needed a raise, the Centre fees would not be affected. A few Centre Representatives reported on their membership's opinions, concerns, and ideas.

One problem was how to deal with Unattached members. They do not benefit from Centre affiliation, yet they pay the full membership fee. In principle that arrangement does not seem fair; however, if they paid only the 60% portion, Attached members may leave the Centres to save money. It was expressed that more discussion was necessary. There was a suggestion to defer any action on the item to a future date. Michael Watson commented on the broad implications of the decoupling and mentioned that there was a way to solve them.

As a result of the strong desire to move ahead on the issue for the benefit of the Centres, the Constitution Committee was directed to propose amendments to the National bylaws that would address the issue. In that way, concrete action may finally be taken by the membership on or before the 2002 General Assembly. The vote was relatively close as National Council votes go: 15 for and 9 against.

The meeting was not over. Indeed, we were only through 30% of the agenda and it was already 2 p.m.! The reports on our publications (the *Journal, Observer's Handbook, Beginners Observing Guide*, and the *Observer's Calendar*) demonstrated that the Society's "other income" from the total sales of our publications was strong. In particular the *Beginners Observing Guide* (BOG) was selling very well at about 1000 copies per year. That is primarily due to the efforts of Leo Enright. (It was also noted that he and his wife now have an asteroid named after them!) Also, the *Observer's Calendar* is selling well, returning $53,000 to the Society. It is the most important source of income to the Society after the *Observer's Handbook* and the membership fees (in that order). Another RASC publication is *Looking Up, A History of the RASC* written by Peter Broughton. Sales have been picking up now that the Society has acquired more copies (the publisher had liquidated the remaining inventory without our knowledge). Also, with the RASC "eStore" now up and running, it is getting more exposure than our previous publisher/distributor was able to provide. In a recent month, sales at the eStore reached $1600!

This raises the question: are we an astronomical society or a business? I think we are both and we have to be. The quality of our publications is one of the highest in the world, but we have international competition. We offer books and specialised resources to a specialised market. The preparation, printing, and distribution of these items cost a lot of money. That money now comes from our membership and the sale of more popular items. The RASC has to be run like a business or our future in promoting astronomy and allied sciences will be short and our role will be taken up by other non-Canadian organizations.

Reports of Special Committees

There were reports from three committees.

The Light Pollution Abatement Committee proposed that the City of Oshawa be awarded the Society's Light Pollution Abatement Certificate at the 2001 General Assembly (GA). The Committee will now work with the GA Organization to promote the award ceremony. Also, a new Observing Certificate Program is close to being ready. A draft was presented at this meeting and a report on the final program will be presented for acceptance at the 2001 GA.

The Public Education Committee is a relatively new initiative. It is a focus for members who work with teachers and educators. Contacts have been made with teaching associations and school boards across Canada. The goal is for the RASC to be a resource for educators that teach astronomy.

The last major report was from the 2001 General Assembly Committee. By the time this article is in print, the GA may be all over but for the shouting. Anything I write may be obsolete by the time you read this unless you read your *Journal* earlier than I do. So, check out the GA Web site at: `www.rasc.ca/ga2001`.

By the way, the GA2002 will be in Montreal, and in 2003 it may be held in Vancouver. I look forward to seeing everyone there!

Opposition Odyssey

by Bruce McCurdy (bmccurdy@freenet.edmonton.ab.ca)

"Mars alone enables us to penetrate the secrets of astronomy which otherwise would remain forever hidden from us."
— Johannes Kepler

Kepler is one of my heroes. He was fascinated with the motions of the planets, more attuned to the "where" and the "when" while others pursued the "what." In 1609, the same watershed year that Galileo pointed the first astronomical telescope skyward, Kepler released his *magnum opus* with the sweeping title:

A NEW ASTRONOMY
Based on Causation
or A PHYSICS OF THE SKY
derived from Investigations of the
MOTIONS OF THE STAR MARS
Founded on Observations of
THE NOBLE TYCHO BRAHE

That thesis contained the first two of Kepler's famous laws of planetary motion, bringing forth ideas that were as revolutionary in their own way as Copernicus' Sun-centred universe, namely that planets travel in elliptical orbits, not perfect circles; and that they move at varying speeds depending on their distance from the Sun at a given time, rather than constant velocities. Asymmetry suddenly ruled the cosmos.

In his classic book *The Sleepwalkers*, the historian Arthur Koestler (1959) describes the groundbreaking discoveries of Copernicus, Tycho, Galileo, and Kepler. Of the latter, he writes: "Kepler was incapable of exposing his ideas methodically, text-book fashion; he had to describe them in the order they came to him, including all the errors, detours, and traps into which he had fallen. *The New Astronomy* is written in unacademic, bubbling baroque style, personal, intimate, and often exasperating. But it is a unique revelation of the way the creative mind works." I can certainly identify with the writing style, if not the genius. More recently, Peterson (1993) suggests there was a hidden agenda embedded in Kepler's exhaustive writing style: "Kepler's goal was to persuade his readers — a highly sophisticated, technically proficient, knowledgeable group of practitioners — that there was no other course possible than to accept his radical theories. He chose a style and approach designed to demonstrate clearly that every conceivable alternative, no matter how attractive initially, ultimately fails the observational test."

As the title of his seminal work suggests, the "star" Mars was crucial to Kepler's discoveries. It has a significantly eccentric orbit ($e = 0.093$) which, coupled with its proximity with Earth, often left it in apparent positions not easily explained. To his credit, he adapted his theories to fit Tycho's observations rather than *vice versa*; when his theory placed Mars only eight arcminutes from the observed position, he kept the observation and threw out the theory. That devotion to scientific rigour was ultimately rewarded with the spectacular success of Kepler's Laws and immortality for their discoverer.

With the major questions long since answered, "wannabe" Keplers in the current day are left to ponder some of the more minor Martian mysteries despite the certainty that immortality does *not* await. Although the data are the flip of a page or a mouse-click away, it can be instructive to apply them selectively and try to reason through why the red planet behaves as it does. As an example of a Martian puzzler, let us consider its current apparition. Mars achieves opposition on June 13, yet its closest approach to Earth does not occur until June 21, over a week later. How can this be? Should not the two planets be closest when they are aligned with each other?

All too often, astronomical magazines give that delayed action only a passing reference, typically without explanation, rushing towards "what" one can observe without paying due attention to the "where" and the "when." I resolved to give the effect, which I shall refer to as "lag time," a closer look. Using the superb software program *Guide 6.0*, I compared the data of opposition and closest approach. I then searched for the time that Mars would again be the same distance from Earth as at opposition. This does not occur until June 30, meaning that for a full 17 days after opposition, Mars will have been closer to Earth than at the exact moment the two planets were aligned. I have tabulated some of the significant data at the bottom of the next page.

Note that the heliocentric longitudes of both planets are identical at the moment of opposition. The next two data points show Earth on its inside orbit gradually pulling ahead of Mars as seen from the Sun; however, Mars is currently approaching the perihelion of its orbit, which it will achieve on 2001 October 12 when it will be 1.38141 astronomical units from the

Sun. By June 21, Mars is about 0.01 AU closer to the Sun than on June13, and about 0.005 AU closer to Earth. The red planet's approach to the Sun is more than enough to offset the gradual angular displacement from Earth. On June 30, Mars is 0.02 AU closer to the Sun than at opposition, which at that point exactly compensates for the 6.5° difference between the two planets' heliocentric longitudes.

A second, albeit much smaller, influence is the fact that Earth is approaching aphelion. While Earth's distance from the Sun increases by only 0.001 AU during the period in question, the more important point is that Earth is moving at close to its minimum orbital speed, meaning it is pulling away from the red planet in longitude at the slowest possible rate.

Simply put, the existence of lag times between Mars' opposition and closest approach is proof positive of Kepler's first two laws: elliptical orbits rule the planetary roost.

As is my wont, I looked for longer-term patterns in the lag time effect. Jean Meeus' *Astronomical Tables of the Sun, Moon and Planets* contains data on all Mars oppositions and close approaches to Earth for the period 0–3000 C.E. I transcribed relevant information for the 94 oppositions from the period 1900–2100 onto a spreadsheet. The events of 2001 are near one extreme in the range of possibilities, but are by no means unusual. About one-third of all oppositions (31 of 94) occur more than a full calendar week before or after the date of closest approach.

The most extreme lag in the period under review took place in 1969, when opposition occurred on May 31 and closest approach on June 9, 8.52 days later. A similar interval will occur on June 3 and 12, 2048, when the two events are separated by 8.46 days. Somewhat predictably, the extreme lag times follow the same periodicities as Mars' opposition cycles, the intervals between similar apparitions in the same area of the sky (*e.g.*, the perihelic oppositions of 1924, 1939, 1956,1971, 1988, 2003), with increasingly higher degrees of correlation at intervals of 15, 32, 47, and 79 years (Meeus 1997). Note that the two extreme lag events are 79 years apart, while the current slightly less extreme one occurs 32 years after 1969 and 47 years before 2048. Also note that all three occur in June.

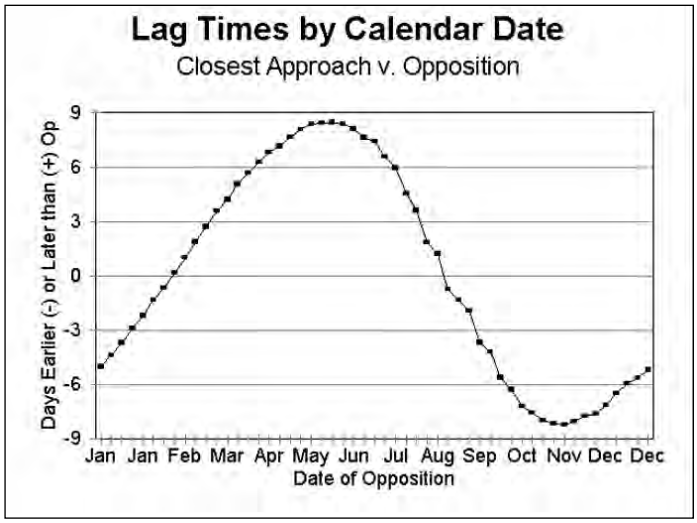


Figure 1 — The lag time between dates of Mars' opposition and its closest approach to Earth is a function of the time of year that opposition occurs. The smoothness of the curve depicted here from selected oppositions between 1900–2100 is interrupted slightly by a relative lack of data points around perihelic oppositions in August and September.

Lags of the opposite sign, where closest approach precedes opposition, are of slightly shorter duration. The extreme event in the period under review takes place in 2084, when closest approach will occur on November 2, and opposition 8.23 days later on November 10. Similar intervals occur at the oppositions of November 7, 2005 and November 4, 1926. Note once again the 79-year periodicity, and that in this case all such events occur in early November. At that time of year Earth is rushing towards perihelion and away from Mars, which serves to moderate the intervals slightly. The absence of absolute symmetry in durations of the two opposing events mirrors the absence of absolute symmetry in nature: the major axes of the orbits of Earth and Mars are out of alignment by some 127°.

	2001/06/13/17:40	2001/06/21/22:57	001/06/30/09:51
Mars heliocentric longitude	262.77	267.40	272.24
Earth heliocentric longitude	262.77	270.62	278.68
Mars distance from Sun	1.47075 AU	1.46060 AU	1.45059 AU
Earth distance from Sun	1.01561 AU	1.01631AU	1.01661 AU
Mars distance from Earth	0.45565 AU	0.45016 AU	0.45565 AU

Mars can, of course, reach perihelion on any date of Earth's calendar; however, we are dealing with "snapshots" of Mars taken *only* at opposition, when Mars is aligned with Earth. As a result, we can effectively apply our own calendar to Mars' position in its orbit. The lag times between closest approach and opposition can therefore be accurately predicted depending on what date opposition occurs (see Figure 1).

The lag times for each opposition for the period 1960–2020 are graphically displayed in Figure 2. A very regular sawtooth pattern emerges, with peaks (or valleys) separated by 15 or 17 year intervals. It is instructive to note that closest approach occurs relatively later than opposition (from valley to peak on Figure 2) very gradually over a series of five or so oppositions, then rapidly plunges from one extreme to the other. For example, the closest approach of 2005, only two synodic cycles from now, will occur 8.18 days before opposition, at the opposite extreme from the current situation. The rapid change occurs from one side of Mars' perihelion to the other. At the perihelic opposition of August 28, 2003, Mars' approach to the Sun will have peaked just as the Earth comes between the two, resulting in a spectacularly close opposition, but minimal lag time, but by November,

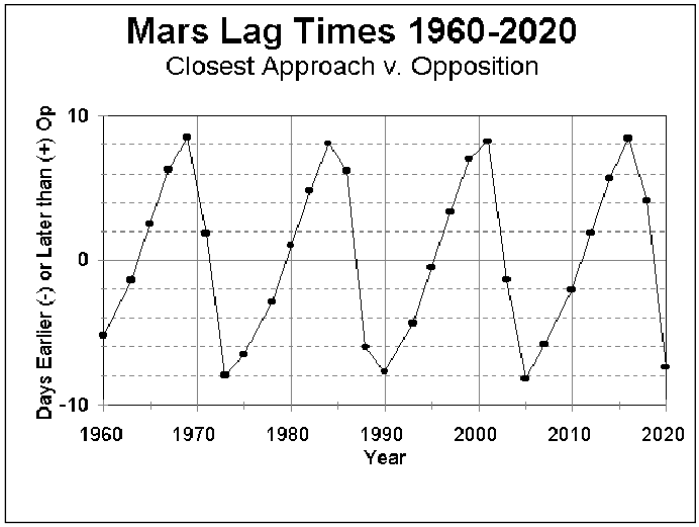


Figure 2 — The lag times of all Mars oppositions and close approaches for the period 1960–2020 are plotted, showing a regular ebb and flow pattern over a 15-to-17 year cycle. Note the gradual build-up from valley to peak followed by the rapid plummet from peak to valley due to reasons described in the text.

2005, Mars will be rapidly receding from the Sun, causing its closest approach to Earth to occur well *before* opposition.

As a final point of interest, Figure 3 shows the relationship between the synodic periods of Mars oppositions *v.* closest approach to Earth. Both types of events have a mean synodic period of 780 days, but in the case of oppositions it ranges by as much as 47 days. Earth takes much longer to catch up with Mars when the fourth planet is speeding through its perihelion than when it is dawdling out near aphelion. The extreme shortest interval between oppositions in the two centuries under review, 764 days, will occur between the oppositions of January 31, 2089 and March 6, 2091 and the longest of 811 days between July 13, 2065 and October 2, 2067. In the first instance, the opposition points straddle Mars' aphelion point, and in the second, its perihelion.

By comparison, the range of synodic periods between one closest approach and the next is much smaller at 31 days. The extreme shortest period of 768 days will occur between the close approaches of January 30, 2089 and March 8, 2091 and the longest of 799 between July 19, 2065 and September 26, 2067. In each case we are dealing with the same cycle (2091 and 2067, respectively), but the synodic periods of closest approaches tend to moderate towards the mean due to the lag times studied above. That moderating effect is much more significant (12 days) around perihelion than at aphelion (4 days). Such a precipitous change in lag time occurred between the events of 1986 (+6.2 days) and 1988 (–6.0 days), as can be seen in Figure 2.

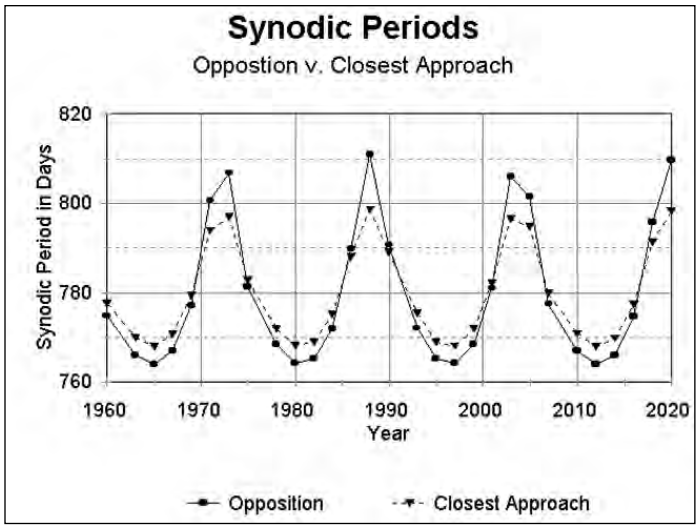


Figure 3 — The mean synodic period for Mars is 780 days, however this can vary sharply depending on where in its orbit Earth overtakes it. The interval is particularly long at the time of perihelic oppositions. The intervals between consecutive close approaches to Earth follow a similar, but more moderate, curve.

The orbit of the "star" Mars remains a subject of considerable fascination, centuries after Kepler painstakingly drew his amazing conclusions from his detailed study of Tycho's careful observations. With the aid of such crib notes as planetary tables and computer programs, it can be rewarding to (re)discover some of the red planet's eccentricities.

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Bruce McCurdy is a Past President of the Edmonton Centre, and is a 15-year volunteer at the Edmonton Space & Science Centre's Public Observatory. He can frequently be found wandering among the planets, perhaps in search of his point of origin.

No More Messiers until You *Finish* Your NGCs

by Joseph O'Neil, London Centre (joneil@multiboard.com)

While living amid the Great Lakes leaves much to be desired in terms of clear and steady night skies, there is the singular advantage of always having a major beach close by on a hot, summer Sunday. When driving to the Lake Erie settlement of Port Stanley, I love to stop at Shaw's Ice Cream Factory, which stands beside the St. Thomas Psychiatric Hospital (Specialists in Forensic Clients, says the sign). I am not quite sure why one institution stands beside the other, but I find comfort in this strange juxtaposition.

Here one can find real ice cream made of real milk, real cream, not "edible oil products," with full rich flavour like the so-called "premium" brands. Once upon a time all ice cream used to taste like "Häagen-Dasz," before we became a society where mediocrity became acceptable as the norm. I took my son into the small ice cream parlour, anticipating for him the ice cream experience of a lifetime. When I asked what flavour he wanted, his reply was "Vanilla." Now this place serves a gazillion or more varieties of ice cream, all them orgasmic delights upon the tongue, but what does my son want, despite my protestations? Yes, plain old vanilla. My wife was worse, as she desired an ice cream bar (boring white stuff between two dark, crusty wafers) that was trying to pass itself off as something edible. Two small vanilla cones and one monster Swiss mocha cone later, we were on our way to the beach. When I cannot convince by words, I lead by example.

That same experience has shown me that amateur astronomers at star parties are of a temperament similar to those of my wife and my son. To illustrate my point, I tell the tale of a man named "Rod" and his giant Dobsonian. Names, dates, and possibly a few "minor" details have been changed to protect the innocent.

" Early one morning, while at a star party, I awoke to the sounds of the building of a monster Dobsonian. I am not referring to a little 16-inch device; no, I am referring to one of those "strap on your hernia belt" monsters so large the owner has to rent a forklift to transport it around."

Early one morning, while at a star party, I awoke to the sounds of the building of a monster Dobsonian. I am not referring to a little 16-inch device; no, I am referring to one of those "strap on your hernia belt" monsters so large the owner has to rent a forklift to transport it around. Oddly enough, it is not just the instrument itself that caught my attention, rather the accompanying accessories that added to the show.

Rod pulled out six sets of digital encoders, three laptops (each with more processing power than the mainframe in the basement of the Pentagon) complete with cellular modems and a digital satellite uplink for faster Internet access, a complete set of every eyepiece that was ever made by TeleVue, Pentax, and Zeiss, three APO fluorite refractors for finder scopes (three different brands in all, for he cannot decide which one is the finest), four different makes and models of the latest in CCD camera technology, a complete set of *RealSky* CD-ROMs, a Rolodex that contains the private, unlisted phone numbers for all IAU members and every major observatory around the world, a complete set of optical repair tools including a portable solar-powered interferometer and Foucault tester, and a red Tele-Tubby. Apparently it was a mascot or something.

I watched fascinated throughout the day as the giant Dobsonian was slowly assembled, while privately wondering if building a CANDU nuclear reactor would take this much work. Of even greater interest was the long line that slowly formed around and around the campground, with people lining up to take a look through the giant telescope. An outside observer could have been forgiven for believing that the next *Star Wars* movie was about to open.

Finally night descended. Night on the second day, that is, as it had taken Rod all day, all night, and all the next day to complete the setup, but neither he nor the people who stood in line seemed to mind. LEDs came to life, servo motors whirred, laptop screens dimmed, modems connected, a feeling of magic and wonder descended over all in the presence of the great Dobsonian. Even the mosquitoes seemed to bite with extra passion. Rod, sitting atop his powered lift chair some five metres above the ground, screamed in amazed excitement, "I finally found M13 by myself!" A roar of approval and applause rose from the assembled crowd, most of whom were lined up, and Rod graciously stepped down to let the next person in line have a look. Taking advantage of Rod's momentary break, I introduced myself and asked if he was possibly up

"To make the subsequent events clearer, I must explain that in order to save weight, many of the components of the giant Dobsonian, such as the mirror cells, the spider, secondary holder, trusses, *etc.*, were machined out of a magnesium alloy, a metal known to burn brightly and at a high temperature, but only under a significant amount of concentrated heat, such as can be provided by a water-cooled laser."

to something a bit more challenging.

"Hmmm, what did you have in mind?" Rod asks.

"Well," I reply, "there are some nice NGC objects not too far away."

"You think we might be able to see them?"

I composed my thoughts and my expression for a moment, and in my best deadpan face mumbled, "Well, a ninth-magnitude object in a 36-inch scope is something I have never tried before, but nothing ventured, nothing gained, eh?"

"It's just that I like the bright stuff. You know, the things that are really neat to look at."

"I'm surprised that you have not charted every *Iridium* satellite flare for the next three nights," I replied, in a tone slightly sarcastic.

"Huh, what's that? I've never seen one of those. Is there any information on the Net about them? If you know the URL, my software will lift the RA and DEC right out of the Web page and send the instructions to the auto-guidance system."

"Well, truth be told, they are naked-eye objects."

At this point, all power to the giant Dobsonian and its various CCD cameras, encoders, and laptops shut down completely. Rob sighed and turned his attention back to "Command Central," formerly a picnic table and now a jumble of wires, lights, and beeping noises.

"Oh, I hate when that happens. You can't say the word 'naked' out loud. It's the Surf Watch program I have on my laptops so nobody can access the, well, you know…adult Web sites. There's a problem with how the program interfaces the voice-activated guidance system on the drive."

"Good thing there isn't a self-destruct system."

"Sssshhhh! There is! I built some of this stuff out of recycled F–16 and F–18 components from the last time they bombed Iraq. When the power is on and anyone says 'Saddam' or a few other key words out loud, the system cooks itself."

I made a lame excuse for a hasty departure, wandered back to the modest 6-inch Dob that served as my instrument, and tried to ascertain whether there was actually astronomy, in any form, present in or around that giant telescope. My campsite proved to be not too far away from it, allowing me to easily overhear the gleeful activity happening around Rod's telescope once power had been restored. To the great amazement and delight of all people in close proximity to the great telescope, Rod was able to find Saturn, Jupiter, and several Messier objects in Sagittarius, although he had to create a link between two of his laptops in order to home in on the Eagle Nebula.

The third night was solidly overcast, and while the situation proved poor for observing the stars, it was prime time for observing human behaviour. Twilight started with an astronomical version of "King of the Hill." Essentially you take two people on top of 2-metre high stepladders on opposite sides of the giant Dobsonian in the twelve and six o'clock positions. When the referee yells "Go!" each player, as in a chess game, is allowed one move at a time. Shouting out loud a single Messier object (such as M31), the idea is to cause the voice activated drive system to point at an object and simultaneously knock your opponent off the ladder. Whoever can topple over the greatest number of opponents without repeating the same Messier object wins. One person who had the audacity to try using non-Messier objects was disqualified for cheating, although he was skilful enough to take out both ladders and the referee using a quick succession of four NGCs as a parting shot.

A lull in nocturnal activity descended upon the campground, and the cloud not only appeared to be thinning out somewhat but we actually had a couple of "sucker holes" forming. I went over to Rod, anxious to suggest that an instrument of its diameter might easily pick off some interesting deep sky objects, even through the high, thin cloud. Despite my best efforts, the term "NGC" kept me *persona non grata* with Rod. It was at this point that somebody decided to start a light war.

A light war is fought using a camera flash pointed down the focuser of a telescope (preferably a large instrument, with an ocular holder of at least 2-inch diameter). You acquire a target in the finder, and fire the flash. The resulting light beam projecting from the end of the telescope will easily flood an entire minivan or large tent over a kilometre away, albeit briefly, in a blinding photonic wallop. Usually the situation becomes a case of "he who has the biggest toy wins." Rod, possessing (like most male amateur astronomers) the emotional mind of a devious child trapped in a middle-aged body, threw himself wholeheartedly into the new contest. Indeed, his newly appointed personal counselor (the shrink with the big refractor) encouraged Rod to participate as a way to overcome his

recent emotional trials. Accorded the benefit of hindsight, I can honestly say this was a very foolish thing to do.

From firsthand experience I can say that rural volunteer fire fighters are some of the most pleasant people you can ever have the fortune of meeting, thought they tend to be a bit skeptical about those issues which they cannot comprehend, such as recycled military technology. I am getting ahead of myself, so I shall first describe Rod's Weapon of Mass Destruction.

Now I will be the first to admit knowing very little about lasers (other than you can buy them in retail stores on a key chain), but from the point of view of an uneducated man, any laser requiring a water cooling system strikes me as being outside the normal application of a hobbyist. When I first saw the device assembled into the focuser of Rod's Dobsonian, I thought perhaps he had a CCD Cookbook camera on steroids. It was, however, the laser in question. I am unsure of why he went this route instead of using a large flash, or exactly what he hoped to accomplish, and I fear the truth may never be fully understood.

To make the subsequent events clearer, I must explain that in order to save weight, many of the components of the giant Dobsonian, such as the mirror cells, the spider, secondary holder, trusses, *etc*., were machined out of a magnesium alloy, a metal known to burn brightly and at a high temperature, but only under a significant amount of concentrated heat, such as can be provided by a water-cooled laser. The King of the Hill contest held earlier had dislodged the secondary mirror, exposing the magnesium holder.

The results of the first firing were almost immediate, and Rod could only watch, mortified in puzzlement at the death of his beloved instrument, which had become the biggest funeral pyre to be seen in Canada since the Vikings left Newfoundland. The fire leapt to Command Central, and all his equipment was quickly gathered in flames. Apparently the very expensive polycarbonate carry cases for all his laptops, eyepieces, etc., had the fire resistance of rice paper. The crowd gathered, the firefighters came, but all arrived too late to save anything, not even the Tele-Tubby. Well, that is not quite true, as the Tele-Tubby was far enough away to be safe, until somebody tossed it into the maelstrom.

In the confusion we lost all sight of Rod, and for the rest of the star party he was not to be found. A week later Rod turned up, disheveled and half starved, in a department store in downtown Toronto. His arms were wrapped tightly around a 60-mm refractor, and the local media reported overhearing him whisper over and over again, "Daddy will never leave you my precious, no, he is so sorry, he'll never do it again."

On a hot summer day I sometimes pick up an ice cream cone before I go visiting Rod in his private, padded room, though it is never vanilla. He prefers a different flavour every time. He does not talk much, mostly grunts when he does make a sound, and although the doctors speak in optimistic terms about his recovery, the look in their eyes, the tone of their voices, and the creepy drawings of charred Tele-Tubbies lying about the room betray the sad truth. As I leave the St. Thomas Psychiatric Hospital behind me on the highway, I think to myself, none of this would have come to pass if we had looked at a single NGC object. I leave you with that moral and the warning, look beyond the Messier list, look beyond.

A member of the London Centre, Joe O'Neil has been interested in astronomy since grade school. In his spare time he enjoys planetary and lunar observing from the light polluted skies of London, and black and white astrophotography from the family farm near Granton, Ontario, about five kilometres due north of Western's Elginfield Observatory.

AstroQuote

A RESEARCHER'S PRAYER FROM AN UNKNOWN SOURCE

"God grant that no one else has done
The work I want to do,
Then give me the wit to write it up
In decent English, too."

Simple Pleasures: ***Best Part of the Day***

by Fae Mooney (faemooney@kermode.net)

"You waste the best part of the day," my friend told me. (She's an early bird; I'm a night owl.) *But I don't waste anything***.**

In the first place, eight hours of sleep are essential no matter when you choose to snooze them (using this logic, you see, I never have to feel guilty for staying up all night stargazing).

Like my friend, though, I do love to wake at the crack of dawn, which comes at the tiny digits on the clock these early summer days at my 54º north latitude location. I love to lie cozily in bed and peep through half-closed eyes out the window at the brightening sky. It's only 3:30, and within my window frame only diamond-white Altair, occasionally occulted by the leaves of the weeping birch outside, sparkles in the pre-dawn sky.

I love to listen to the sweet chorus of birds as they wake from slumber, a soothing lullaby to someone not long in bed. I smile contentedly and snuggle into the covers, take a deep breath of fresh fragrant air drifting through the open window on a cool morning breeze, then slip off into sweet dreams. I haven't wasted the morning at all.

A few hours later warm beams of sunshine filtering through the birch play at the foot of my bed and beckon me to rise. For me, the best is still to come.

On my northerly spot on the planet, from about June 10 to July 10, long hours of daylight remain close to constant, with the Sun rising in the far northeast around 5:00 a.m. and dipping shallowly below a north-northwestern horizon 17 hours later; twilight lasts all night!

Summer twilight. For me, this is the best part of the day — and year. To slip outside into my little forest out back and watch the long slanting rays of a gold and copper sunset, the peach and coral and mauve-gray clouds in the dusky-blue sky, and twilight time that lingers till dawn.

Late evening... and the song of a Swainson's thrush hidden in the forest celebrates end of day. A red squirrel scampers about, unaware of the late hour. The honey-sweet fragrance of garden flowers drips from the cool, moist air...

Then, to stand in my meadow and look up into a clear night sky that never darkens to black, and tease the stars from a background almost as bright as themselves. Three diamond-bright stars forming the Summer Triangle sail high in a midnight sky of royal blue: Vega, almost directly overhead, Deneb to the northeast, and Altair farther to the southeast. Westward I spy a bright coppery star at the base of a summer-faded bent kite called Bootes. This is Arcturus. Farther west and closer to the horizon sparkles aquamarine Spica. These are the brightest sparks of light in my northerly summer sky.

Sparkling like crystal above the rugged mountaintops to the north, in a sky still milky-green from sunlight, dances golden Capella. Polaris, marking due north and riding high at this northern latitude, pops into sight.

Westward, the stars of the Big Dipper don't sparkle with their winter brilliance now that they reside in a nightless summer sky. Likewise for queenly Cassiopeia to the east, but I love to watch for their appearance in the deep periwinkle blue.

Each day, nature saves the best for the last during a northern summer, and I'm glad I'm still wide-eyed to appreciate it.

No, I haven't wasted the best part of the day at all. Not as long as I stop to appreciate it. Summer days are long and blooming with potential, but a northern Canadian summer is all too brief. Life is briefer still. How could I waste the best of what each day offers? And not take time to consider Thoreau's wise words? "I went to the woods," he wrote, "because I wished to live deliberately... and see if I could not learn what [nature] had to teach, and not, when I came to die, discover that I had not lived."

It's when we become too busy to look and not really see…or watch…or observe. When we just hear and don't stop to listen…When we fail to breathe deeply…or ignore the soft caress of a mild summer breeze on bare skin. And, yes, even when we neglect to consider those tiny sparks of light twinkling above our heads during summer twilight. That's when we waste the best part of life itself.

A season as short as a Canadian summer should never be wasted, especially during the best part of each day. No matter where we live across this great land, for all of us the best part of every 24 hours lasts for at least 16 (time out for sleeping).

And somewhere during that best time we need to squeeze in a little bit of work. We've got to keep our summertime priorities right! Right?

Unattached member and freelance writer, Fae Collins Mooney loves to spend the best part of every day enjoying her natural surroundings at her home in northwestern British Columbia.

Reviews of Publications
Critiques d'ouvrages

Peterson Field Guide to the Stars and Planets, by Jay M. Pasachoff, with Monthly Star Maps and Atlas Charts by Wil Tirion, pages 578 + x, 11.5 cm × 18.5 cm, Houghton Mifflin Company, 2000, Fourth Edition. Price US$19.00, paperback (ISBN 0–395–93431–1).

This is going to be fun! Having heard so much about (without ever having read) previous versions of this guide, I could not wait to have a very thorough look at the latest edition. What would I see when I opened the book? As it turns out, an explosion of well-written and well-organized information is what I found.

The Field Guide to the Stars and Planets begins with a short introduction on how to get the most from the book, followed by an overview of what can be seen in the sky. There is a series of seasonal sky tours, richly illustrated with photographs, and supplemented with twenty-four all-sky charts for different northern and southern latitudes, and different times of the year. The constellations are shown both with and without the patterns made by joining the stars with lines. That is followed by chapters on the constellations; stars, nebulae, and galaxies; double and variable stars; and the one hundred forty page sky atlas section.

Chapter seven, "Atlas of the Sky," is focused around very detailed star charts that are jam-packed with information. All of the charts in the book have been done by Wil Tirion, the world's leading celestial cartographer. Stars dots are sized for magnitude and coloured for spectral class. Deep-sky object symbols are scaled for angular size and colour coded for class. There are fifty-two charts with extensive accompanying descriptions. They are precessed to the epoch 2000.0 and contain 25,000 stars brighter than magnitude 7.5, with about 2,500 deep-sky objects. The small scale of the charts may be a drawback at the telescope, but it is a field guide and not intended to be a primary star atlas. Beginners might suffer initially from a mild case of information overload.

All of the vibrant colour is wonderful in daylight, making the charts fun to study, but at night, beside the telescope, the charts' major design flaw leaps out at the user (or rather, fails to leap out, as we shall see). Consider the fact that many of the stars in the sky are red. They are represented by red dots in the atlas. Under a red flashlight, the dots disappear. Fortunately, the stars can still be seen as circles, since the dots are outlined in black ink. Galaxies, on the other hand, are represented by small red ovals filled in with a pink colour. They vanish completely when viewed with a red flashlight. Their associated catalogue numbers are clearly visible on the chart, but the symbol itself is impossible to see. Sadly, both open and globular clusters suffer a similar fate under red light. They are represented by yellow circles outlined with red ink, and they too perform a vanishing act. An amber filter on my flashlight showed all such objects nicely, but compromised dark adaptation. Unless you have a photographic memory, you will have a hard time using the charts under normal nighttime observing conditions to locate galaxies and star clusters.

Following the sky atlas is an excellent chapter on the Moon with a series of detailed maps, ample descriptive material, and eclipse and lunar phase information, complete with predictions up until the year 2010. (All of the time-sensitive content of the guide is good until 2010.) Subsequent and equally thorough chapters describe the planets, comets, asteroids, meteor showers, and the Sun. In the planets chapter there is a series of eleven "Graphic Timetables of the Heavens," one for each year from 2000 to 2010. They are a simplified version of the "Skygazer's Almanac" published annually in *Sky & Telescope*. They look a bit puzzling if you have never seen one before, but there is good explanatory text in the accompanying pages. Less well-explained are the strip charts showing the positions of Mars, Jupiter, and Saturn from 1998 to 2010. There is a short chapter devoted to co-ordinate systems, time, and calendars, as well as one on telescopes and binoculars.

The appendices contain lists of the constellations, brightest stars, information on spectral classification, the nearest stars, double and variable stars, properties of the planets and their satellites, and more. There is a good glossary, as well as a bibliography and index.

Overall, the *Peterson Field Guide to the Stars and Planets* is well written and carefully structured, with lots of cross-reference between chapters in an effort to maximize benefit to the user. The writing is clear and easy to understand. The illustrations have been carefully chosen to convey the beauty of the heavens and the excitement of the latest astronomical discoveries. The book's cover is colourful and attractive. I was pleased to see Lacerta, a less well-known constellation and a personal favourite of mine, highlighted there. It is a lovely book — beautiful, compact, and complete — printed on glossy, heavy stock and well

bound to withstand the extensive use for which it was intended. It is an excellent all-in-one reference for both the beginner and experienced amateur astronomer. It combines many elements of the RASC's *Observer's Handbook* and an introductory astronomy textbook into a single volume, making it a prime choice for the beginning amateur astronomer, as well as a compact resource for travelers.

Mary Lou Whitehorne

Mary Lou Whitehorne is a life member of the RASC, and has been very active for many years at both the local and national levels. In recent years her energies have been directed towards improving astronomy education across Canada. Mary Lou holds both the Messier and Finest NGC Observing Certificates, as well as having been awarded the Society's Chant Medal.

The Celestial Sphere, A Narrated Tour of the Night Sky, by Robert Dick, VHS video, 49 minutes, Starlight Theatre, P. O. Box 79, Rideau Ferry, Ontario, Canada, K0G 1W0, 2000. Price CDN$25.00, plus $6.00 shipping and handling (ISBN0–9685970–2–5).

For me the title *The Celestial Sphere* invokes a monsoon of memories of trying to figure out all the complicated celestial navigation that I had to learn in my introductory astronomy class. Immediately, images of right ascension, declination, co-latitude, hour angle, sidereal time, celestial equator, and ecliptic sprang to my mind. Then I noticed the sub-title: *A Narrated Tour of the Night Sky*. Whew! Okay, that looks a little more like something for consumption by the average human being!

The Celestial Sphere is an impressive piece of work by RASC member Robert Dick. It is the result of several years of dedicated effort in capturing video images of the night sky. In less than an hour (49 minutes), the viewer is given a brief introduction to sky motions, the north star, asterisms, constellations and stars, the Milky Way, nebulae, star clusters, meteor showers, fireballs, aurorae, solar eclipses, and some sky mythology. It is not a computer simulation; it is the actual sky in speeded-up motion, and it is wonderful to watch. Forty-nine minutes can hardly do justice to so many topics, but a picture is worth a thousand words. The video does a remarkable job of introducing the basics to the novice, so novices should be able to get much more out of their first tentative observing sessions under the real sky.

The video begins at a star party, with amateur astronomers obviously enjoying the view through their telescopes. Mention is made of the problem of light pollution for the urban sky watcher, and then the show moves on to the dark skies of rural Canada. We know it is Canada because we see Rob Dick himself in big boots and parka marching through the wintery landscape to set up his trusty camera by driving its tripod legs deep into a snow bank for stability. I appreciated that bit of realism.

The video is well organized and follows a logical progression of topics, starting with the reason for day and night, then moving on to the seasonally changing patterns of the constellations. The section dealing with the changing view of the heavens is well illustrated and accompanied by good, clear descriptions. Graphic overlays on the video illustrate the celestial equator, the winter and summer Milky Way, the major constellations, and the north and south celestial poles. Season by season, we are treated to a detailed tour of the most prominent constellations, with their star patterns outlined by stick figures, and labels for the brightest stars. The circumpolar sky is seen rotating about Polaris, with Ursa Major, Ursa Minor, and Cassiopeia featured in leading roles.

Next comes the seasonal sky, where a progression of constellations is seen rising, transiting, and setting throughout the year. The prominent constellations march steadily across the sky in smooth motion, first with the stick figures joining the stars, and then without the connecting lines. A few of the brightest deep sky objects are pointed out and described.

Comets Hyakutake and Hale-Bopp lead into a short section on meteors, meteor showers, and fireballs. This section, although short, is quite impressive with beautiful footage that clearly shows the radiant points of both the Leonid and Geminid meteor showers. There are some beautiful, dancing, auroral curtains and a quick look at a solar eclipse. All in all, *The Celestial Sphere* is a delightful summary of what can be seen in the night sky, with clear illustrations of, and explanations for, the observed motions of the sky.

I have only one suggestion to offer: it would have been nice to include a female voice among the male voices heard on the video. I fully understand that the exclusive use of male voices is not an intentional exclusion of the female gender, but if we want to attract women to the hobby we must actively seek opportunities to promote their participation in astronomy. Something as simple as the inclusion of a woman's voice would serve immediately to recognize and welcome women's involvement in the hobby of astronomy.

Mary Lou Whitehorne

See note following previous review.

Astrocryptic

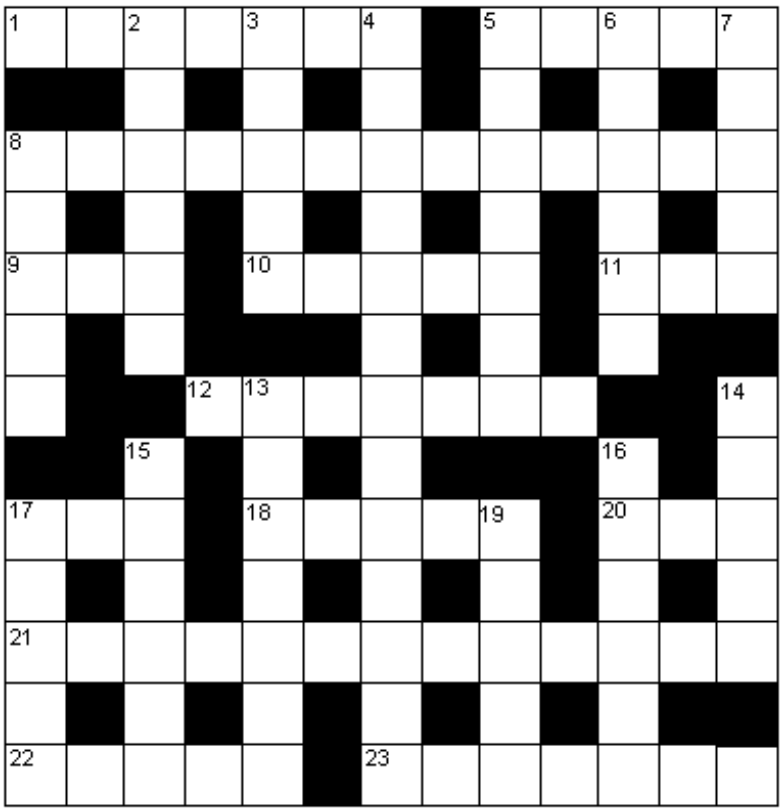
by Curt Nason, Moncton Centre

ACROSS

1. Destroyed a mall in the middle of a belt (7)
5. It follows a sphere around another (5)
8. Somehow they grab Bingo cards to describe creation (3,4,6)
9. Time reversal in the Omega Nebula (3)
10. Initially view lunar eclipse in right ascension back around Uranus (5)
11. Changing directions for a mate of Aries (3)
12. Continental safari bagged an eclipse at the solstice (7)
17. Wordsworth's time for Hesperus, once called back (3)
18. No fake Messier in Virgo's galactic kingdom (5)
20. Key European capital in the outskirts of Halifax (3)
21. Our 10 CCD lines resolved to give wavelength (6,7)
22. We get from Umbriel a natural satellite, by Jove (5)
23. Back again, half the RASC joins this Centre (7)

DOWN

2. Northern lager swirls around a high quality ocular (6)
3. Capella maybe holds the beast at Las Campanas (5)
4. Viewing power misrepresented in a fiction mag (13)
5. Returning sick after losing hope near Uranus (7)
6. The bear driver will cry back about a broken toe (6)
7. Herb sounds temporal (5)
8. Walter's sheepish comment falls on half deaf ears (5)
13. An algebraic expression for feeding a baby (7)
14. Celestial compass leads 6 back to the extreme party (5)
15. Madly tail an air pump into the southern sky (6)
16. Initially, Progressive Conservative head scrambled to become a bowl star (6)
17. He was wildly keen about the head of his comet (5)
19. Greek sorceress appears in reformed Earth orbit (5)



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Publications and Products of
The Royal Astronomical Society of Canada

Observer's Calendar — 2002

This calendar was created by members of the RASC. All photographs were taken by amateur astronomers using ordinary camera lenses and small telescopes and represent a wide spectrum of objects. An informative caption accompanies every photograph.

It is designed with the observer in mind and contains comprehensive astronomical data such as daily Moon rise and set times, significant lunar and planetary conjunctions, eclipses, and meteor showers. The 1998, 1999, and 2000 editions each won the Best Calendar Award from the Ontario Printing and Imaging Association (designed and produced by Rajiv Gupta).

Price: $15.95 (members); $17.95 (non-members)
(includes postage and handling; add GST for Canadian orders)

The Beginner's Observing Guide

This guide is for anyone with little or no experience in observing the night sky. Large, easy to read star maps are provided to acquaint the reader with the constellations and bright stars. Basic information on observing the Moon, planets and eclipses through the year 2005 is provided. There is also a special section to help Scouts, Cubs, Guides and Brownies achieve their respective astronomy badges.

Written by Leo Enright (160 pages of information in a soft-cover book with otabinding which allows the book to lie flat).

Price: $15 (includes taxes, postage and handling)

Promotional Items

The RASC has many fine promotional items that sport the National Seal. Prices include postage and taxes. Included are a *Cloth Crest* (size 11cm with the background white and the stitching in royal blue - $11), *Lapel pins* (blue, white, and silver - $5), *Golf shirts* (white, available in small and medium - $24), *Stickers* (size 7.5cm, blue with white overlay - $1 each or 2 for $1.50), *Thermal mugs* (in blue and white - $5.50), *Toques* (Black with Yellow lettering - $17), *Key chains* (Clear arcylic and Blue/white - $2.50).

Shop On-Line at www.store.rasc.ca

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