December/décember 2001 Volume/volume 95 Number/numéro 6 [691]

Journal

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

INSIDE THIS ISSUE

December/décembre 2001

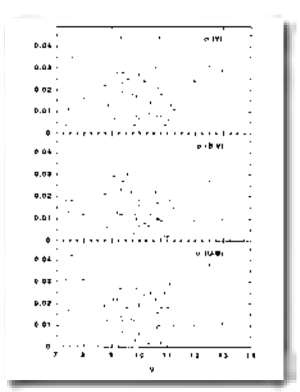
Journal

Vol. 95, No. 6 Whole Number 691

contents
table des matières

FEATURE ARTICLES/ARTICLES DE FOND

RESEARCH PAPERS/ARTICLES DE RECHERCHE



Broadband Photometry
p. 267

COLUMNS/RUBRIQUES

Total Eclipse Temperature Measurements
p. 252

Second Light
p. 257

Reflections
p. 256

Book Reviews
p. 284

Analemma in the Sky
p. 273

AstroCryptic Answers p. 247

Cover:
The Canada-France-Hawaii Telescope during an observing run in April 2000, which was deep-surveying the Coma galaxy cluster. During the nearly 1 hour image, the photographer attempted to "write" CFHT with a red flashlight on the "catwalk." (Image by Dave Lane).

President's Corner

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

There is a famous etching by Daumier, a copy of which used to hang in Chandrasekhar's office at Yerkes Observatory. It portrays a venerable old astronomer on his balcony looking through a small telescope at some fascinating small fuzzy object. His loving wife is excitedly tapping him on the shoulder and pointing to a giant comet that he seems to have missed.

I interpreted the etching as poking fun at the serious professional observer for concentrating so intensely on details that he forgets to step back to see the larger perspective, and misses the important discoveries. My interpretation may not be the only one; however, it can be useful. One also can imagine the woman as the astronomer who does large, all-sky surveys (*e.g.* Nancy Houk's reclassification of the HD catalogue). Surveys often are not appreciated in their own time, but in the long run, they are valuable because of the very large number of direct and indirect discoveries made with the data. Other observers examine interesting objects from the survey in great detail in order to understand them. Both approaches are important.

The recent discovery by Vance Petriew (Regina Centre) of a comet is a case in point. He was at a summer star party and surveying objects for an observing certificate when he noticed a fuzzy object that wasn't supposed to be there. His discovery was confirmed by Richard Huziak (Saskatoon Centre) and they reported it to Brian Marsden at Harvard. The observing certificate program was an important element in the process of discovery. Also important were Vance's alertness and curiosity, as well as Rick's experience.

In Canada, as well as in the US, funding for "small" professional telescopes (1–2 metre class) is being sacrificed in order to support access to very large telescopes (8–20 metre class). On the one hand, this VLT access is important and will hopefully lead to a new understanding of the faintest limits of the local and distant universe. On the other hand, the demand for time on the VLTs, makes it very difficult to do surveys or any other kind of long-term project. It is important to note that not all interesting objects are faint and not all faint objects are interesting. Interesting bright objects (*e.g.* the next nearby supernova) can be studied in detail using well-equipped, small telescopes.

What is essential is a balance. Compared with the VLTs, small telescopes are very inexpensive, so it doesn't make sense to close them down, since they provide a unique perspective and feed discovery information to larger telescopes for detailed study. However, in the present funding climate, it is unlikely that this situation will change dramatically.

Is this an opportunity for amateur astronomers? More and more amateurs are buying or building substantial-size telescopes (equipped with modern detectors and automation

Journal

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

The *Journal of The Royal Astronomical Society of Canada* is published at an annual subscription rate of $80.00 by The Royal Astronomical Society of Canada. Membership, which includes the publications (for personal use), is open to anyone interested in astronomy. 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:

The Royal Astronomical Society of Canada
136 Dupont Street
Toronto, Ontario, M5R 1V2, Canada
Internet: rasc@rasc.ca
Website: www.rasc.ca
Telephone: (416) 924-7973
Fax: (416) 924-2911

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

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

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

software). Amateurs and professionals should be working together more than they are. The AAVSO (American Association of Variable Star Observers) is a good place to start, but there are many other ways to collaborate. Seek out the professionals at the local observatory or university and ask what you can do to help. Professionals can advertise vacant support positions to the RASC community. At the Dunlap Observatory, we have hired an enthusiastic RASC member as telescope operator with great positive impact on morale. Volunteer work also is usually appreciated, though it is sometimes limited by union contracts.

There are many possibilities, and we need to begin a dialogue on innovative solutions. The best place to start is with the professionals who are members of the RASC.

CALL FOR NOMINATIONS

At the Annual Meeting to be held in Montreal on the weekend of May 18-20, 2002, the following Executive positions are up for election:

President	Two-year term
First Vice President	Two-year term
Second Vice President	Two-year term
Secretary	Three-year term

Every voting member who is not less than twenty-one years of age has the right to stand for election in these positions.

The Nominating Committee shall prepare a list of one or more candidates for each elected office for which an election must be held. This list shall be presented to the Secretary of the Society at least sixty days before the annual meeting. Any other eligible member of the Society may be nominated for any elected office for which an election must be held. Such nomination (in writing, signed by at least five voting members of the Society, and confirmed by a written statement of acceptance from the candidate) must be delivered to the Secretary of the Society at least sixty days before the annual meeting.

If you have any questions about the process of election, please contact the Chairman of the Nominating Committee:

J. Randy Attwood
E-mail: attwood@istar.ca
Phone (905) 624-4629

Editorial

by Patrick Kelly, Assistant Editor (patrick.kelly@dal.ca)

Amateur astronomy, like a lot of other pastimes, is a serious pursuit for a sizable percentage of those who have chosen it as a hobby. Many of the people who have contributed to this publication by sharing their astronomical activities have invested enormous amounts of time (and/or money) to improve their skills, their equipment, or to pursue a particular observing goal.

While many of us enjoy success when on an astronomical hunting expedition, after a certain period of time the memory of the event tends to fade, often to the point where it is no longer in our conscious memory. Even the greatest of successes may lie forgotten in the attic of the mind, lying under a growing layer of dust until dredged back into the light by some unexpected event. It may be that you are flipping through an old observing log and come across the entry for that incident. Perhaps you are talking to a fellow observer and he or she mentions an object for which you had an interesting observation. In either case, the memory of the event is rekindled.

It is an interesting quirk of human nature that the same effect does not apply equally to those events that led to "less than a successful conclusion." Sometimes, "disaster" might be a better term to describe the particular situation, or sometimes it was an observation that did not work out as expected but had a humourous aspect. Perhaps this inability to forget these types of occasions is part of the process of learning from our mistakes. I am sure that every Centre has its collective history of things that have not turned out as expected. These foibles of the past are often passed on to the next generation of observers while stopping at the Tim Horton's after a long observing session. I would like to share one of these events with you, in which I was both the perpetrator and the victim.

It started out, innocently enough, back in the Twentieth Century, with a group from the Halifax Centre observing at our Beaverbank site. The date was May 14, 1988 and I was observing some deep-sky objects in the constellation of Serpens Caput. While star-hopping with my finder, I came across a star that was not plotted on my copy of *Sky Atlas 2000*. It was a sixth magnitude star, and you can imagine that there was some degree of excitement raised by its "discovery." It appeared to be too stellar to be a comet, and we kept a careful watch on it to see if it might be slowly moving, indicting that it could be an asteroid. No movement was observed, even at high magnification. There was no galaxy near its position, ruling out a possible supernova. That left two reasonable possibilities: an error in the *Sky Atlas 2000* (less likely) and a nova (more likely).

The only way to decide the matter was to consult a higher authority. In this case, that authority was the newly-released *Uranometria 2000*, owned by Centre member Hugh Thompson. A quick check confirmed that instead of discovering a nova, I had merely found an error in the *Sky Atlas 2000*, as a 6^{th}-magnitude star was plotted in the *Uranometria* at the exact spot of the mystery star. That, as the saying goes, would have been that, except…

We now fast-forward to the evening of July 31, 1989. Once again I am at the Beaverbank site with the usual observing group. While trying to locate the galaxy NGC 6118 in Serpens I made the following notation in my observing log: "Galaxy not visible which is not surprising as it is only about 7° above the horizon. …while looking for it I did find a field star which I would have expected to be in *Sky Atlas 2000*. It was near the plotted position of the galaxy, yet did not appear to be coincident with it. Made sketches. Will have to check *Uranometria*." Sound familiar? At the time, neither myself nor anyone else there seems to have recalled the events of the previous summer. It was only when I was at Hugh's place, flipping through the *Uranometria*, that I began to feel what Klingons call nIb'poH (déja vu to humans). When I asked him, Hugh had the same feeling, but it was not until we looked at the chart in question that it dawned on us that we had done this before!

You may be wondering why I am relating this story to you. I am hoping that if you have a similar story to tell, you will send it to me for inclusion in a future issue. Granted, my past requests for submissions have had "less than a successful conclusion," but as you can see, I do not always learn from past mistakes!

Correspondence
Correspondance

CALL FOR PAPERS

Royal Astronomical Society of Canada
General Assembly — GA2002AG
May 17–19, 2002 — McGill University,
Montreal, Quebec, Canada

GA2002AG will be held on the campus of McGill University, Montreal, Quebec on May 17, 18 &19, 2002. The RASC General Assembly is an opportunity for members of the Society from across Canada to debate and discuss issues of importance to the Society. Two National Council Meetings and the Society's Annual General Meeting will be organized in order to address this important aspect of the General Assembly. In addition, informal social occasions will also provide the opportunity for society members to meet and discuss issues in a relaxed atmosphere.

In 2002, Dr. Paul Hodge, editor of the *Astronomical Journal*, will give the Helen Sawyer Hogg lecture. Keynote speakers Brent Archinal of the United States Geological Survey Astrogeology Team, David H. Levy, author and comet-hunter extraordinaire, and Dr. Jaymie Matthews, University of British Columbia, are also scheduled to attend.

The General Assembly will also provide a forum for Society members to make presentations on astronomical subjects of interest. To this end, the Organizing Committee of GA2002AG is issuing a call for papers to be presented at a dedicated paper session in Room 151 of the Samuel Bronfman Building, McGill University, on Saturday, May 18, 2002 from 9:00 a.m. to 5:00 p.m.

Suggested topics for papers include:

- visual, photographic or electronic research projects in all aspects of observational astronomy
- equipment and observatory design and construction
- public education projects in astronomy
- local, regional and national light pollution abatement efforts
- astronomy in literature, music and the arts
- historical studies in astronomy

Audio-visual aids including overhead projectors, slide projectors and an LCD projector will be made available. It is strongly suggested that presenters requiring a laptop computer bring their own, although efforts will be made by the Organizing Committee to have a computer available on-site.

The Organizing Committee reserves the right to place a time limit on presentations based on the number of paper presentations received. Restrictions on length of presentation will be communicated to participants no later than 30 days prior to the paper session.

Poster presentations are also encouraged and display space in the lobby of the Samuel Bronfman Building will be available.

It would be appreciated if all paper titles, abstracts and author lists be submitted in plain text as part of an email message. Paper abstracts for consideration should be sent to:

Anthony F.J. Moffat
Département de physique
Université de Montréal
C.P. 6128, Succ. Centre-Ville
Montréal, QC, H3C 3J7
Canada

The deadline for submissions is
March 21, 2002.

Email: moffat@astro.umontreal.ca
Web: www.astro.umontreal.ca/~moffat
Tel.: (514) 343-6682
Fax: (514) 343-2071

News Notes
En Manchettes

POLITICS AND MARS-ON-EARTH

Some 23 million years ago, a small asteroid plowed into what is now Devon Island in Nunavut. Upon impact, the asteroid excavated the 20-kilometer wide Haughton crater. For the past three years, however, the Haughton crater has been home to an international team of scientists, engineers and students who have set-up camp during the summer months as part of the Haughton-Mars Project. The researchers have travelled to the inhospitable regions of Devon Island because it is believed the Haughton crater offers a useful analogue to the types of terrain likely to be found on the planet Mars.

Free-roaming of the researchers about Houghton crater has, however, been brought to a halt in recent times due to the placement of "no trespassing" signs over most of the area. Residents of the Griese Fiord community, situated some 200 km away from Devon Island, have put the signs in place claiming that the crater falls within their traditional hunting grounds. The small Griese Fiord community has asked that a formal Inuit Impact and Benefits Agreement to be negotiated, and are looking for an agreement that will potentially include financial compensation for the use of the crater. Talks between community officials and the project team leaders are scheduled to take place this November.

MODERN TESTS ON OLD TELESCOPES

The techniques and procedures employed by 17th and 18th century telescope makers is a subject that has not received great attention from historians of science. So writes Dr. Randall Brooks, of the Canada Science and Technology Museum, Ottawa, in the first of two articles that have recently appeared in *Bulletin of the Scientific Instrument Society* (issues number 69 and 70). The two articles set out to bring together details of 18th century mirror grinding techniques according to journal commentaries and the 1772 painting of an optician's workshop by Johann Zoffany. The historical development of mirror grinding methods is studied in detail and most interestingly Brooks suggests that the major barrier to constructing consistently good telescopes in the 18th century was the lack of good testing methods rather than the actual mirror grinding procedures.

Prior to 1859 and Leon Foucault's invention of the knife-edge test, instrument makers had to rely primarily on their skill and patience for the consistent production of good telescope mirrors. Indeed, Brooks notes that James Short (1710–1768), perhaps the most famous of 18th century instrument makers, routinely made a number of sets of primary and secondary mirrors (*i.e.*, for Gregorian-style reflectors) and then 'married' the pairs by trial and error according to how well they produced stellar images.

ANOTHER PRAIRIE METEORITE

The successes of last years Prairie Meteorite Search (PMS) have continued into this one. A new meteorite from Manitoba has been unearthed by Dan Lockwood, point-person for the PMS and undergraduate student at the University of Calgary. The story behind the discovery of this new meteorite is remarkable, and the tale begins with Mr. Gerald Pittman reading an article about the PMS in the *National Post* newspaper. Mr. Pittman, as a young boy, first noticed the odd rock on a window sill in his grandfather's house in Gilbert Plains, Manitoba, sometime during the 1940's. His grandfather, Herbert William Cutforth, had emigrated to Manitoba from England in approximately 1900 and had presumably collected the odd stone from somewhere near Gilbert Plains. Mr. Pittman says of his now deceased grandfather, "He liked to collect odd things. The rock was regarded as a curiosity, and was never described as a meteorite."

Years later the rock was given to his grandson, Mr. Pittman, who kept it for another four decades before beginning to wonder if it was a meteorite. When he read of Dan Lockwood's summer research he contacted him to have the rock identified. Dan Lockwood describes seeing the rock: "I could tell immediately that the sample was a meteorite. I was shocked that it turned out to be so easy to have a meteorite handed to me." However, he says of a potential difficulty, "The problem then was if this rock was a new meteorite or a transported fragment of a previously known find. It looked just like other rusted iron meteorites, some of which are quite abundant and widely distributed."

The Gilbert Plains specimen is the 4th meteorite recovered in Manitoba and the 60th meteorite recovered in Canada. It sets the Canadian record for the longest time between collection of a meteorite specimen and its identification by researchers. This provides encouragement that many more meteorites wait unidentified in the hands of prairie families.

The identity of the meteorite as a possible new discovery could only be established through further research, so Mr. Pittman agreed to have his specimen forwarded to Stephen Kissin of Lakehead University, Thunder Bay, Ontario, who is Canada's authority on iron meteorites. Dr. Kissin sliced a small piece off the specimen to examine its interior. While additional research will further describe the specimen, Steve Kissin says, "I think it is a fairly safe bet that this is a new meteorite. The interior structures indicate

that it is probably a member of the Group IIIAB irons, none of which are widely distributed. None of this group is previously known from Canada.

While researchers are delighted with this new discovery, they would like to know more about the meteorite's origin. Says Alan Hildebrand of the University of Calgary, "We would like to know how and where Mr. Cutforth acquired the specimen although, since nearly a century has passed since it came into his possession, we may never know where it was found. However, perhaps someone in Gilbert Plains has another piece of the same meteorite or a family there may have preserved a record of its discovery. Sometimes large iron meteorites break up high in the atmosphere and fall in great swarms so that hundreds of meteorites may lie in the area." The amount of rust on the meteorite's surface indicates that it probably fell thousands rather than hundreds of years ago.

If anyone believes that they have found a meteorite they are encouraged to contact Dr. Alan Hildebrand (University of Calgary; `hildebra@geo.ucalgary.ca`) or Dr. Martin Beech (Campion College, The University of Regina; `martin.beech@uregina.ca`). Further details on the Prairie Meteorite Search can be found at `www.geo.ucalgary.ca/PMSearc/`

Astrocryptic

by Curt Nason, Moncton Centre

Here is the solution to last issue's puzzle:

1 A	L	2 G	E	3 N	I	4 B	■	5 P	R	6 I	S	7 M
R	■	A	■	I	■	E	■	L	■	O	■	A
8 S	I	R	■	9 M	A	R	K	A	R	I	A	N
I	■	N	■	O	■	E	■	T	■	O	■	A
10 A	V	E	R	Y	■	11 N	E	E	D	I	N	G
■	■	A	■	■	■	I	■	A	■	■	■	E
12 D	O	U	B	13 L	E	C	L	U	S	14 T	E	R
I	■	■	■	I	■	E	■	■	■	I	■	■
15 G	I	16 B	B	O	U	S	■	17 A	L	T	A	18 R
I	■	O	■	N	■	H	■	R	■	A	■	H
19 T	E	M	P	E	R	A	T	E	■	20 N	E	E
A	■	B	■	S	■	I	■	N	■	I	■	A
21 L	I	S	T	S	■	22 R	A	D	I	A	N	S

Physical Models of Haidinger's Brush

by Maxwell B. Fairbairn (mbfairbairn@hotmail.com)

The visual effect that occurs when observing plane polarized light was first described by the mineralogist Haidinger in 1844. More than a century later Shurcliff (1955) reported that a similar effect occurs with circularly polarized light. To this day the cause of the effect is not fully understood, although it is almost certain that it involves the absorption of short wavelengths in the *macula lutea*, the "yellow spot" of the retina.

It is surprising that knowledge of the existence of the effect is not widespread, even among scientists and others working in optics and related fields. It appears that astronomers are no exception to this general rule.

Description of the Brush

Although the effect does have a medical application in the treatment of amblyopia ("wandering" or "lazy" eye), as far as the author is aware it has never been subject to rigorous clinical study for a significant number of individuals, so that knowledge of its properties is largely based on anecdotal evidence. Like the related effect of Maxwell's Spot, the image is entoptic, *i.e.* it originates in the eye and is not that of a real external object and cannot be photographed.

The effect is both weak and transient. For plane polarization the observer sees a faint elongated yellow stain pinched at the centre and variously described as an hourglass, a bow tie or one half of a Maltese cross, perpendicular to the plane of polarization, *i.e.* the plane of the electric vector. Generally more difficult to see, and parallel to the plane of polarization is a similar shape in blue, indigo or purple stretching about only half the distance of the yellow arm. The figure is centred on the fovea (that part of the retina in which our vision is most acute, and on which we fixate when scrutinizing small objects), subtending a visual angle of about 3 degrees, and fades in about 3 seconds. If the plane of polarization is slowly rotated, the figure will re-appear and rotate with the plane of polarization, remaining visible as long as the plane of polarization rotates. Most people see the yellow arm as continuous and the blue disjoint, although this may reverse as the image fades. Others claim that the continuous colour is the one closest to being vertical, and many see the yellow arm to be narrowest when it is horizontal, *i.e.* parallel to the line joining the eyes.

If the observer waits long enough for the image to fade and then averts the gaze to an unpolarized source, a negative after-image will appear briefly, with the formerly yellow arms blue and vice-versa (J.B. Tatum, personal communication 2000). The author has verified the after-image existence for himself and in others, but has never read in any literature, scientific or otherwise, any mention of it.

The effect can only be seen in light sources with a blue component (wavelengths nominally less than 500 nm) and so is invisible in, say, yellow and red sources. The effect seems to be enhanced in purely blue light, the yellowness replaced by a darker blue sensation.

For right-hand circular polarization the (upright) observer, in both left and right eye, sees the yellow brush with its long axis oriented in an upwards to the right and downwards to the left direction, an azimuth of approximately +45°. The image is fixed with respect to the retina, so that it will rotate only if the observer tilts the head. For left-handed polarization the azimuth is −45° approximately, so that the left and right figures appear to be rotated with respect to each other by ninety degrees. The orientation may differ slightly between the left and right eye.

In his original report, Shurcliff stated that the figure is as prominent for circular polarization as for plane polarization. However, he later wrote that for some observers the circular effect is significantly weaker than the plane and for others the opposite is the case. Most people can see the effect, although many need some tutoring beforehand, while others see it quite spontaneously, and can even detect the partial polarization of the blue sky, without the aid of an analyzer.

Techniques for Observing the Brush

To see the effect most vividly one needs a bright uniform source with no distracting patterns. Blue sky, or a white cloud, away from the direction in which the sky light is most polarized, or a brightly illuminated sheet of white paper or a light bench make good sources. A clear computer screen in a darkened room is also suitable. If such sources are viewed through a plane polarizing sheet, the image will appear and fade as described. If the observer waits a few seconds and then quickly rotates the polaroid by ninety degrees, an image, *more vivid than the original*, will spring into view with both blue and yellow arms more or less equally prominent — a Maltese cross. (It is the author's contention that the image so formed is not Haidinger's brush, but rather the brush reinforced by its previous after-image). Once the image has faded, then it can be refreshed to equal vigour by quickly rotating another ninety degrees in either direction.

To see the after-image, the observer needs only to wait until the figure fades and then quickly remove the polarizing sheet from the field of view.

For circular polarization, the equivalent of the above technique is to switch quickly between two circularly polarizing sheets of opposite handedness.

What's Causing It?

Although the cause of the effect is not fully understood (indeed the nature of the effect has not been fully investigated) the most plausible theories suggest that it is a manifestation of Maxwell's Spot in the case of polarized light, a model first proposed by Helmholtz in 1866 (Helmholtz 1924)[1]. Normally, we are not aware of the existence of the blue-absorbing macula (*i.e.* we do not wander around with yellow spots in the centre of our field of view) and it only makes itself apparent, and then only briefly, under special circumstances, such as switching one's gaze from a yellow field of view to a blue field.

Helmholtz observed that the yellow spot contains a special layer of nerve fibres, the fibres of Henle, which "run radially out from the centre of the fovea in all directions, proceeding principally parallel to the surface of the retina". He proposed that these fibres, like many organic fibres and membranes, were birefringent and behaved like uniaxial crystals, with the optical axis in the fibre's longitudinal, and that the extraordinary ray of blue is more strongly absorbed than the ordinary ray, *i.e* the fibres are dichroic. With a radial alignment of these fibres and vertical polarization, yellowness is enhanced above and below the foveola, the central point of the fovea, and blueness either side of it.

It is interesting to note that the text and accompanying colour plate simulation in Helmholtz's treatise clearly indicate the *yellow arm aligned with the plane of polarization*. Since we now define the plane of polarization in terms of the direction of the electric field vector, could it be that the plane of polarization was defined differently in 1866, some seven years before the publication of Maxwell's electromagnetic theory (1873) and when the nature of light was considered to be "transverse vibrations of the luminiferous aether"?

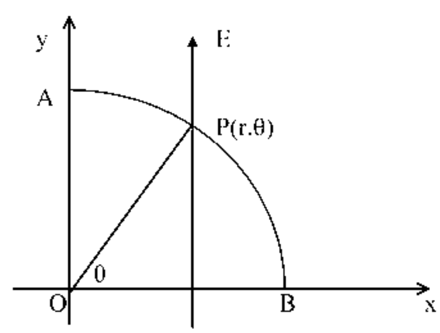
It turns out that this is not the case. In giving his explanation of the cause of the effect, Helmholtz clearly indicates that he takes the plane of polarization of the extraordinary ray to contain the optical axis. Any textbook on optics will state that the extraordinary ray is polarized this way and it can be easily verified experimentally with the following equipment: a crystal of Iceland spar, a plane polarizing sheet and a bowl of water.

The author can only conclude that when Helmholtz wrote his book, he mistakenly believed that the yellow arm aligned with the plane of polarization and, although the mistake may have been detected later, it was never corrected. Subsequent editions of the treatise were added on to, but not revised. This observation does not in any way invalidate the Helmholtz model of the cause of the effect, but simply requires that it is the ordinary ray that is more absorbed, not the extraordinary ray, as happens in dichroic crystals, some absorbing the extraordinary ray and others the ordinary ray. The author does have a theory as to why Helmholtz would make such a mistake, but it would be too lengthy a digression to elaborate on it here.

The Helmholtz Model and its Simulation

It is now known that macular absorption is caused by two organic molecules. The macular carotenoids, xanthophyll and zeaxanthin are isomers ($C_{40}H_{56}O_2$) and feature long zig-zag chains with puckered ring structures at each end (Merck Index 1996). Because of the dissymmetry of each they both exhibit circular dichroism (Joyce M. Edward 2000, private communication). By biochemical standards they are rather simple molecules and are to be found in the food we eat, *e.g.* zeaxanthin is the agent that gives corn its colour.

The macular absorption profile is well known (Wyszecki & Stiles 1967; Bone, Landrum & Cairns 1992), peaking near 458 nm with a small blended secondary peak near 485 nm. Absorption for wavelengths longer than 540 nm is negligible. It is known that the density of the macular pigment may vary by more than an order of magnitude between individuals, which may explain why some people can see the effect quite spontaneously, whereas others cannot see it at all. Being dichroic, however, is not enough to induce the effect; there must be some alignment of the long axes of the molecules, in which case they will exhibit linear dichroism. In this case we consider a tendency to align about the foveola.



As shown in the diagram, consider a plane vertically polarized beam incident on a layer of thickness τ of aligned macular pigments. The alignment may be with long axes radial, as shown by line OP, or concentric as shown by arc APB. The electric field vector E has radial and tangential components $E\cos\theta$ and $E\sin\theta$ respectively. If O is at the centre of the foveola, then τ will decrease with increasing eccentricity. At $\lambda = 458$ nm, where the macular absorption is at its maximum,

[1] Helmholtz's important treatise on physiological optics was first published in 1866 but not translated into English until 1924. Both Maxwell's Spot and Haidinger's Brush are discussed in detail in this work.

let κ and $\kappa+\varepsilon$ be the attenuation coefficients perpendicular and parallel to the molecular axes respectively. With $\alpha=e^{-2\kappa\tau}$ and $\beta=e^{-2\varepsilon\tau}$ and radial alignment, the absorption is

$$A_\lambda\left(r,\theta\right)=E_\lambda^2\left[1-\alpha(\cos^2\theta+\beta\sin^2\theta)\right] \quad (1)$$

For concentric alignment, it is simply a matter of swapping the trigonometrical factors. The effect of macular absorption is to subtract blueness from its input, or, alternatively, to add yellowness. We may define a yellowness quantity ΔY such that

$$\Delta Y\left(r,\theta\right)=\int_0^\infty M\left(\lambda\right)A_\lambda d\lambda \qquad (2)$$

where $M(\lambda)$ is the normalized empirical macular absorption profile, a weighting function inside the integral (hence the λ is parenthesized rather than subscripted). In practice this function is available in tabulated form, and the range of integration would be 380–540 nm, the function being zero elsewhere. For random alignment, or unpolarized light, ΔY is independent of θ, and, if there is no component less than 540 nm, it is zero.

For radial alignment it can be seen that ΔY is maximized along the y-axis and minimized along the x-axis, whereas the reverse is true for concentric alignment. For a partial alignment, radial or concentric, we would expect that, in the presence of plane polarized light that ΔY would be enhanced above the norm of unpolarized light in some parts and depressed in others, depending on the trigonometrical factors.

How does Equation 2 lead us to a computer-generated simulation? The answer turns out to be the essence of simplicity. Computer graphics limit us to the rendering of colour by the use of varying strengths of three broadband additive primary colours, Red, Green and Blue (RGB). By a happy coincidence, when both are normalized to the same scale, the emission profile of the standard blue primary, CIE chromaticity coordinates (0.15, 0.06), is strikingly similar to the macular absorption profile, the former peaking at 450 nm, and negligible for wavelengths greater than 540 nm. Both peak in that part of the spectrum that we would describe as Indigo.

With the plane of polarization inclined at angle ψ with respect to the x-axis and concentric alignment, the pattern $R'G'B'$ $(r,\theta+\psi)$ resulting from such an impinging uniform plane polarized RGB source is thus

$$\begin{bmatrix} R' \\ G' \\ B' \end{bmatrix}=\rho\left(r\right)\begin{bmatrix} 1 & 0 & -\xi\cos^2\theta \\ 0 & 1 & -\xi\cos^2\theta \\ 0 & 0 & 1-\xi\sin^2\theta \end{bmatrix}\begin{bmatrix} R \\ G \\ B \end{bmatrix} \quad (3)$$

where $\xi< 1$ is a measure of the difference between maximum and minimum absorption and $\rho(r)$ is the tendency of the molecules to align as a function of the distance from the centre. It should be noted that the above transformation is also valid for elliptical polarization with the major axis aligned with ψ. Programmers should note that for some RGB and ξ values the result may be out of gamut and produce spurious images, this limitation being imposed by the hardware.

The exact form of $\rho(r)$, which must fade away eventually to confine the image to just a few degrees, is of course not known, but if we assume that it is roughly proportional to the macular pigment density itself, then a simple exponential decay, e^{-r}, serves as a suitable starting point. Indeed, an acceptable likeness of the brush, in both colour and form, is produced when this is the case.

Circular Polarization

By itself, the Helmholtz model is not sufficient to explain the appearance of the image in the cases of circular polarization. Following Shurcliff's discovery, attempts were made to either modify the Helmholtz model or propose alternatives. Some, however, such as those proposing that the eye contains the equivalent of an anisotropic-dichroic crystal (Summers, Friedmann & Clements 1970) or a quarter-wave plate (Seliger & McElroy 1963), do not stand up to scrutiny and are readily dismissed.

Shurcliff & Ballard (1964) suggested that some transparent layer in front of the macula is birefringent and behaves like a retarder, but did not go into the detailed implications. For such a retarder with the slow axis very nearly horizontal, the left and right handed polarizations will be "squeezed" into left and right elliptical polarization with the major axes aligned at ±45° to the fast axis, independent of the phase difference δ, which controls the eccentricity but not the orientation, and would form fixed images on the retina as described.

The effect of the same retarder on plane polarization would also be to induce elliptical polarization, with two exceptions, when the plane of polarization is parallel to the slow and fast axes, which would then constitute two preferential directions for detecting the brush. In general, the orientation of the major axis φ of the ellipses and the angle of the plane of polarization ψ, to the slow axis, is given by

$$\tan 2\varphi = \cos\delta \tan 2\psi \qquad (4)$$

where δ is the phase difference. A consequence of this is that the figure will rotate as the plane of polarization rotates, but the arms of the brushes will not line up precisely parallel and perpendicular to the plane of polarization (with exceptions at $\psi = 0, \pi/4, \pi/2, 3\pi/2$) but will be rotated slightly clockwise or anticlockwise. For the effect to be much the same strength for both plane and circular polarizations, the retarder should approximate an "eighth-wave" plate. At $\delta = \pi/4$ the maximum amount of this rotation is nearly 5 degrees, a discrepancy which, if it exists, the weakness of the effect notwithstanding, may be discernible under properly controlled clinical conditions[2].

Concluding Remarks

In order to finalize a suitable model it is necessary to answer three questions. Is the alignment radial or concentric? Why

[2]The author has observed that in his own case the figure does not always align precisely parallel and perpendicular to the plane of polarization, and seems sometimes rotated slightly clockwise or anticlockwise. By itself, this observation of course does not constitute concrete scientific evidence supporting the above.

does the image fade? What is the source of the birefringent layer?

There are three candidates for the birefringent layer: the cornea, the lens and the arrangement of nerve cells and fibres in front of the macula. Whether or not the lens is involved could be established by a simple experiment. If the lens were the source, those people who have had the lens of one eye replaced by an artificial lens as treatment for cataract would be able to detect circular polarization in one eye, but not in the other.

Shurcliff & Ballard (1964) propose that the alignment of the axes of the macular caretenoids must be radial, and explain the effect as follows. "Incident linearly polarized light will then be absorbed more strongly in some parts of the pattern than in other parts and consequently some parts will fatigue more than others. When the vibration direction of the light is suddenly changed, the varying degrees of fatigue are revealed as a subjective radial pattern. Presumably no such dichroism or orientation pattern applies to longer wavelength (yellow and red) light; consequently a yellow sensation dominates in those regions where fatigue-to-blue has occurred."

The author supports the following view. It is entirely feasible that the macular caretenoids may be aligned concentrically in or among the radial fibres, rather like the concentric threads of a spider web. If this were the case and an observer suddenly switches the gaze to vertically polarized light, then blueness will be enhanced above and below the foveola, and yellowness to the left and right. In other words, in principle, Helmholtz was right. The image then fades because of fatigue and the associated development of a negative after-image, which because of the entoptic nature of the effect, remains superimposed exactly on the original. Since the effect is weak, the two images soon wash each other out (and Maxwell's Spot fades for the same reason), unless the polarization is suddenly removed, whereupon the after-image becomes apparent. This argument is also valid for purely blue light, since the L and M cone sensitivities are active in the blue region (Stockman & Sharpe 2000). If the plane of polarization is suddenly rotated by 90 degrees, or the handedness is suddenly switched, the after-image will reinforce the refreshed image.

To demonstrate the fact that the effect has as much to do with colour fatigue and after-images as it does with polarization, try the following experiment. Draw a circle, 2 to 3 cm diameter, on a white sheet of paper (alternatively, use a computer drawing program). Divide the circle into four equal sectors and uniformly fill one pair of vertically opposite sectors with indigo and the other with yellow. This makes a very poor simulation of Haidinger's brush, but that is not the aim of the exercise.

From a suitable distance, fixate upon this figure long enough to develop a negative after-image, which may then be observed on a white background by averting the gaze slightly, or on a black background by closing the eyes. At first the after-image will be a crisp complementary colour version of the original, but as it fades it will distort so that one colour will become continuous, as happens with Haidinger's brush. A criticism of the simulation is that it does not show the yellow to be continuous, but rather the arms of the figure appear to radiate from a point. However the fading after-image is an excellent likeness of the brush, *i.e.* the after-image of the simulation is a better simulation than the simulation!

Those readers who have not observed the effect are strongly urged to do so, if only for the sheer pleasure of discovering a "new" sense. Plane polarizing sheets are readily available, and even a pair of Polaroid sunglasses, though not ideal, will do the job.

Acknowledgements

The author would like to thank Jeremy B. Tatum for many illuminating discussions and for deriving Equation 4.

References

Bone, R.A., Landrum J.T., & Cairns, A. 1992, *Vision Research*, 32, 105

Merck Index 1996, 12th ed, 10197, 10248

Seliger, H.H., & McElroy, W.D. 1963, *Light: Physical and Biological Action*, (Academic Press Inc.: New York), 303

Shurcliff, W.A. 1955, *JOSA*, 45, 399

Shurcliff, W.A., & Ballard, S.S. 1964, *Polarized Light*, (D. Van Nostrand Inc.: Princeton), 95

Stockman, A., & Sharpe, L.T. 2000, *Vision Research*, 40, 1711

Summers, D.M., Friedmann, G.B., & Clements, R.M. 1970, *JOSA*, 60, 2

von Helmholtz, H. 1964, *Treatise on Physiological Optics*, transl. ed. J.P.C. Southall, (Dover Publications, Inc.: New York), 2, 304

Wyszecki, G., & Stiles, W.S. 1967, *Color Science: Concepts and Methods, Quantitative Data and Formulae*, (1st ed.; Wiley: New York)

Max Fairbairn completed his MSc. in Astrophysics at the University of Victoria, BC, in 1972. Since then he has taught Physics and Computer Programming at various tertiary institutions. He lives near Sydney, Australia.

TOTAL SOLAR ECLIPSE TEMPERATURE MEASUREMENTS

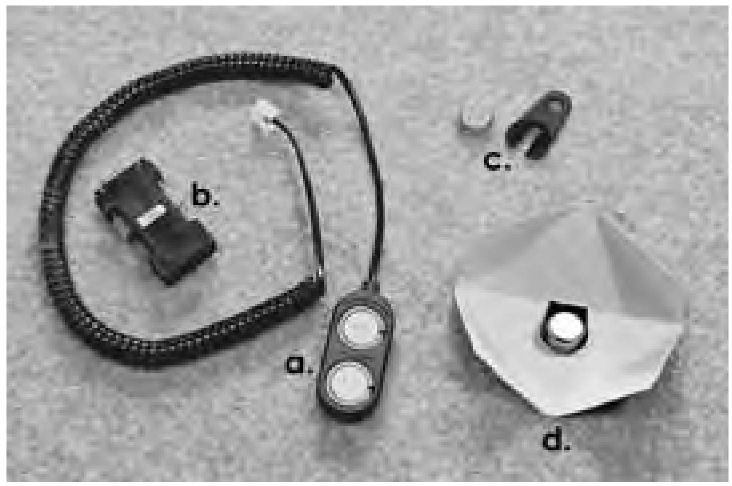
by Bill Ronald, Vancouver Centre (ronaldb@home.com)

During previous total solar eclipses, I had considered measuring the temperature changes during totality. However, being one of those unfortunates who always has an irresistible need to photograph eclipses, I never felt that there would be enough time to look, photograph, and also measure something else. Normally, I spend about half of totality photographing and the other half just looking. Recording temperatures would cut into my precious observing time. I have also tried to get others to do projects, such as spotting shadow bands, but they usually get so caught up in the excitement that they 'totally' forget.

The weight and size restrictions for travel to the June 21, 2001 eclipse in Zimbabwe were quite rigid, so I needed a small, light, automatic recording system that was hands-free and affordable. In the past, I had looked briefly at some of the automated sensor systems and found them either bulky, expensive, limited to one sensor or to require a portable computer. Some of the eclipse temperature models being developed require taking measurements at up to four heights, so multiple sensors are definitely preferred.

It was with some interest then, that in April I read an e-mail on the Solar Eclipse Mailing List (SEML) from Dr. Jim Huddle of the USNA, Annapolis, regarding a small, programmable, affordable, temperature-measuring and recording device called an iButton. Jim had learned about it from another eclipse-chaser and SEML member Stephen McCann of Southampton, UK.

The iButton is a microchip-based device made by Dallas Semiconductor (SC) of Texas. The Thermochron version that interested us has a built-in temperature sensor, a clock/calendar and memory. It is designed to be attached to temperature-sensitive shipments for continuous monitoring. Because data has to be downloaded quickly and easily by portable units at points along a route, the iButton is designed to be simple to handle, rugged and waterproof. It is basically a 16-mm computer chip armoured in stainless steel, which can connect to a programming/reading system through a "1-Wire™ Net" connection. Input/output is achieved through a Windows program, "iButton Viewer32," which is a free download from the Dallas SC Web site.

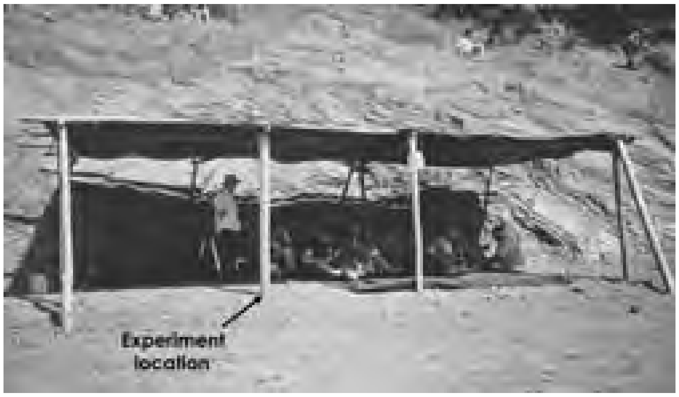


a) Blue Dot Receptor (dual) with cable; b) Universal Serial Adapter; c) iButton and flanged fob; d) iButton in fob, mounted in an"awning" cover."

After a quick email exchange with Jim, I went on-line and ordered several Thermochron F52 iButtons plus flanged fobs to conveniently hold them, and a Universal Serial Port Adapter with a Blue Dot Receptor to interface them with my computer. Much to my dismay, I received an email back from Dallas SC saying that the F52s were back-ordered for several months. I then tried ordering the more limited F51s but again was told that they were back-ordered for at least 6 to 8 weeks. I was about to give up for this eclipse when I received another email from Dallas SC offering to sell me three F50s, which were the "engineering-test" models of the F51s. They were used, older (they have an internal power supply that lasts about 10 years) and I would have to sign a waiver to receive them. No guarantees, but what the heck, I took them.

While waiting for them to arrive, I corresponded with a small group, which included Jim Huddle, Stephen McCann and Dr. Edward Hanna of Plymouth University, UK, who were interested in collecting and correlating data from several sites in Zambia and Zimbabwe. Three of us were going to use iButtons and the consensus was that it would be best to measure at heights above ground of 150 cm, 30 cm, 0 cm and if possible 5 cm below ground level. Of course, I only had enough instruments for the above-ground measurements ... unless I could get a volunteer for the below-ground readings with another type of thermometer?

The F50 iButtons are limited to a minimum interval of one reading per minute and a recording sensitivity of 0.5°C, within a temperature range of −10 to +85°C. To confirm their accuracy, they needed preliminary calibration against "standard" thermometers. Two of my F50s



The very welcome shaded area.

agreed exactly with my two "standard" mercury thermometers, while the third routinely read 0.5°C low.

At one sample per minute, the F50s collect data for about 1.4 days, but I was leaving Vancouver one week before eclipse day. No computer would be available to initiate collection on eclipse day, so the iButtons had to be pre-programmed. Luckily, they have some nice features to manage this. They can be set with an extended time-delay before data collection starts, and they can be set to either roll-over or stop collecting when the buffer is full. Of course, I wanted them to stop so that my eclipse data would not be overwritten. Because of the long time-delay, it was necessary to check the clock accuracy over time. Stephen McCann tested his iButtons and found that his F50 had a drift of about two seconds per day. Therefore, markers would be needed to indicate specific times so that all the chips could be time-aligned around the eclipse period. Jim Huddle and I successfully carried out tests immersing the iButtons in ice and also heating them by rubbing them between our fingers to place either low or high temperature-spike markers, at known times within the collected data.

In addition, the measurements must be taken in the shade, so suitable covers had to be found to protect the iButtons from direct insolation. I experimented with various shapes, including inverted 'dixie cups', which unfortunately acted like little ovens! The best designs were 4″×4″ white cardboard cards folded into either 'flutes' or 'awnings'. Both worked well when hanging, even in a wind, but the 'awning' was the best if taped to a flat vertical surface.

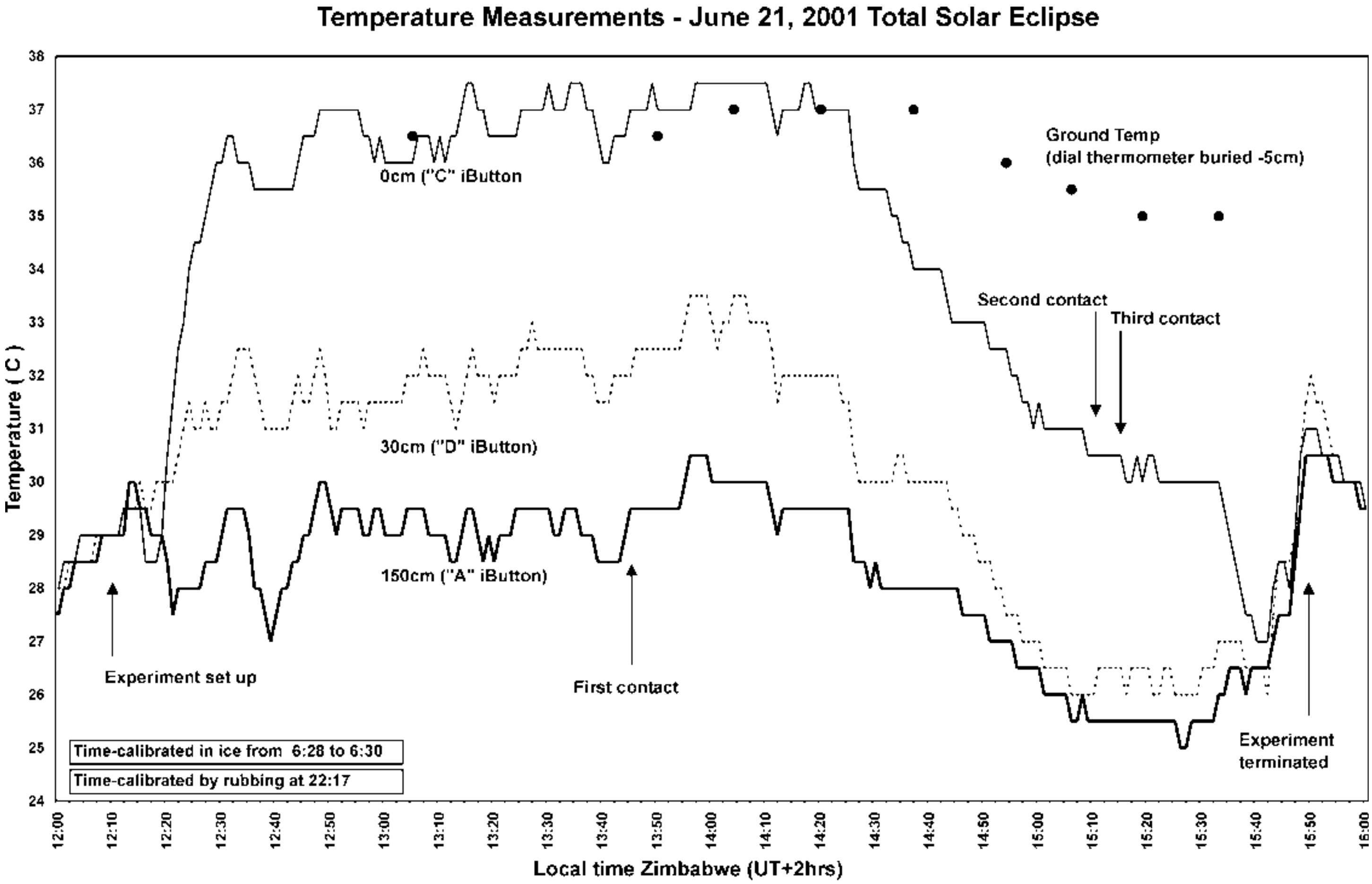
The moment of truth finally arrived! On June 14, the day I left Vancouver, with great trepidation and many rechecks, I programmed the iButtons to start collecting at 15 minutes after midnight, local Zimbabwe time (UT+2) on June 21, Eclipse Day. I wouldn't be able to tell whether everything had worked correctly until I got back home and downloaded them in July.

At breakfast, in Harare on Eclipse Day, I dipped them all into ice for exactly two minutes, starting at 6:28 a.m. to time-align them. Then it was off to the eclipse! Twenty-one of us and a driver, all jammed into a small bus for a three-hour ride. The bus was so small that we even had to use the fold-down, aisle seats.

The viewing site was in the foothills of the Mavuradonha Mountains overlooking the Zambezi River Valley to the north. It appeared to be a stone quarry and it was very hot. The nearest vegetation was some distance away from the tarp-shaded site we had previously arranged to have built, so I chose one of its supporting posts as my experiment location. I taped a 152-cm (60″) seamstress' tape to the shaded side of the post and then taped iButtons, with 'awning' shades, by their fobs at 150 cm, 30 cm and 0 cm. I also buried and shaded the dial of a pre-calibrated laboratory, dial thermometer so that its average shaft depth was −5 cm. The dial was in a small cavity so it could still be read. My wife Linda "volunteered" to take readings and I had a red flashlight to use when it got dark during totality. Reading the dial was easy during the partial phases, but became a real problem as the darkness grew. It involved kneeling down on the rough ground to get close enough to read by the weak red light.

The iButtons were the easy part, once they were mounted they just sat there "collecting." All I had to do was remember to take them down when we left. Unfortunately, because totality was around 3:15 p.m. and sunset was about 6:20 p.m. local time, we could not stay until fourth contact. We had to be packed up and heading back on the long road to Harare by 5:00 p.m. Even at that, we arrived back well after dark, which, with the busy roads and uncertain security conditions in Zimbabwe, was a little nerve-racking. In the remaining excitement of the day, I didn't remember to find any ice at dinner. Thus, as I was climbing into bed at around 10:15 p.m., because we had a 4:00 a.m. wake-up call for a flight to Victoria Falls, I suddenly had to leap up and dig out the iButtons to insert a time marker by rubbing them.

The layout of the experiment (the photographer to the right is Alan Dyer).



Excel spreadsheet graph summarizing the results.

The next time I thought about the experiment was July 10, the day after we returned from South Africa, and all the worries came rushing back. Had I put in the correct time-delay? Did they really stop sampling when the buffer was full? Did one of them not keep good time?

Nervously, I started to download the data into an Excel spreadsheet. The markers were obvious and all nicely aligned. There appeared to be matching temperature drops of various amounts around the right time. I set a time column to indicate local Zimbabwe Standard Time (UT+2) because the iButtons had been recording in PDT (UT–7), and added 0.5°C to all of the "C" (0 cm) iButton values — a correction of the amount by which it had always recorded too low in pre-eclipse calibrations. Finally, I highlighted the appropriate data cells and instructed Excel to plot, and there it was. As you can see from the graph, the 0-cm level had the highest air temperature and showed the greatest drop, followed by the 30-cm, and then the 150-cm. The −5-cm initially gave similar temperature values to the 0-cm but then showed the least drop.

My final conclusions? The Thermochron iButtons are convenient, affordable, hands-free, and easy to transport. The 0.5°C accuracy and one sample per minute limitations are slightly restrictive but still provide useful data. With lots of pre-calibration measurements against "standard" thermometers and clocks, one can correct for variations in the units.

Will I try it again? Yes, but if possible, with four of the new F53s which have better clock accuracy and a wider temperature range, and which will be ordered well ahead of time. I would also like to try hanging the shaded iButtons in the open, rather than taping them to a post under cover, so that there is better air circulation. However, I will never again try to talk my wife into volunteering to take ground level measurements, on her knees, on hard rocky ground, in the heat, in the dark, with a small, weak, red-light flashlight.

Having retired from a career as a biologist with the Research Branch of Agriculture Canada, studying the 'micro' world of plant virus structure, Bill Ronald is now able to concentrate on his interest, the 'macro' world of astronomy. Chasing eclipses is a great way to view new skies and it appeals to his wife Linda because totality must often be viewed from exotic terrestrial locations.

Climate Change and Astronomy

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

In recent years, the topic of global climate change (*a.k.a.* global warming) has received a lot of attention in the media, often associated with the "greenhouse effect" and international initiatives to reduce the combustion of carbon-based fuels. The waste products of consuming fossil fuels, notably carbon dioxide, are the principal component of anthropogenic (*i.e.* human-induced) climate change. The consequences of global warming are typically negative: droughts, extreme weather events, floods from rising sea levels, *etc.* This is certainly the "mainstream" view, and the media seem to take great delight in sensationalizing any scientific data that support the gloom-and-doom predictions; however, there are other points of view that do not enjoy the same exposure.

"What has this got to do with astronomy?" you might ask. The answer is: quite a lot, particularly regarding the variability of the Sun. (Leslie Sage discussed the increased magnetic activity of the Sun and its connection to climate in his August 1999 *JRASC Second Light* column.) I do not consider myself an expert on this issue, but I would like to highlight some of the astronomical aspects of the debate, having followed them for some time. This summer, I took advantage of a professional development opportunity to "play hooky" from my regular scientific pursuit (underwater acoustics) and attend a local scientific conference entitled "Global Warming and the Next Ice Age." What an excellent opportunity to listen to the international experts on the scientific issues of global climate change! The website for this conference has been recently updated to include a summary by the organizers; this can be found at: `www.mscs.dal.ca/HalifaxClimateConference`

This Italian painting depicts the freezing of the Lagoon of Venice in 1706, during the "Little Ice Age" associated with the Maunder Minimum of Solar activity. Coincidence, or something more? (Anonymous, 18th Century, reproduced with the permission of the Galleria Querini Stampalia, Venice.)

One of the most important things that I learned at the conference is that there is no such thing as "normal" when it comes to the subject of Earth's climate. To use the word "normal" in such a context, it would be essential to state the time interval under consideration. Even since the last Ice Age, there have been long stretches of history much warmer and much cooler than now: During the Mediaeval Warm Period of the 10th to 14th Centuries, grape vines were abundant in England and the Vikings crossed the Atlantic to settle Greenland and Newfoundland (at least). During the Little Ice Age from 1450–1850, cool temperatures in North America and Europe resulted in shorter growing seasons and severe winters. Around 1700, there was a famine in Scotland caused by poor harvests. The River Thames regularly froze, and "frost fairs" were held on its surface. The accompanying figure is an 18th Century Italian painting that depicts the freezing of the Lagoon of Venice in 1706. (Warning: even the above statements are considered to be controversial by some climate scientists!)

The fact that the average global temperature has risen dramatically over the last century does not seem to be much in dispute: the "mainstream" climate scientists and the "contrarians" pretty much agree. What they do not agree on is (a) are the consequences good or bad? (b) will the warming continue unabated? and (c) to what extent are humans responsible? The answers to these questions will determine how we should deploy our knowledge, abilities, and resources to counter the trend (if controllable) or to mitigate its effect (if uncontrollable). Astronomers have a role to play in this, if they want to.

With all the coverage of global warming, it is strange that journalists pay so little attention to the Sun, the Earth's source of heat, light, and — ultimately — life. It stands to reason that variation in the Sun's energy output would have an immediate effect on the Earth's climate, as would variation in the Earth-Sun distance and the axial tilt of the Earth. (There is even suggestion that the mere existence of the Moon has a had a role in stabilizing the motion of the Earth, making possible the development and maintenance of life on Earth.) Astronomers know that all these factors vary over different time scales. I am going to dispense with the orbital and tilt factors right away: these vary over time scales of thousands of years, and may indeed be connected with the arrival and departure of the Ice Ages, but they are unlikely to be connected with the historical variations in global temperature over decades and centuries.

It has long been speculated that the extreme cold of the Little Ice Age was causally connected to reduced solar activity. The Sun showed essentially no sunspots during the interval 1645–1715, known as the Maunder Minimum, and no aurorae were seen for 37 years. Although the precise physical connection between sunspot activity and the Earth's climate is not known, as we learn more about the Sun itself and what goes on in our upper atmosphere, some possible mechanisms begin to emerge.

By far the best overall conference presentation summarizing the role of the Sun in climate change was that by Pål Brekke of the NASA Goddard Space Flight Center, Deputy Project Scientist of the SOHO mission (SOHO = SOlar Heliospheric Observatory). Luckily, his presentation is available online at `zeus.nascom.nasa.gov/~pbrekke/presentations/USCAPITOL/`

Brekke points out that the cyclical variation of the total (wavelength-integrated) irradiance of the Sun is only about 0.1% and this by itself is insufficient to account for all of the observed climate variations; there would need to be an amplifying mechanism. For example, the average flux at ultraviolet wavelengths, known to affect ozone production and depletion in the upper atmosphere, has increased by 3% since the Maunder Minimum and can vary by as much as a factor of 8 over half a single solar cycle.

More recent (and thus still somewhat controversial) is the suggestion that solar cosmic rays (charged particles in the solar wind) play a role in cloud formation. There are data showing correlation of global cloud cover with cosmic ray flux. If true, this would be a good candidate for an amplifying mechanism driven by the Sun. Astronomical support for this hypothesis is found as far away as Neptune, whose highly-reflective atmosphere varies in brightness by 3–4%, in phase with the solar cycle: Neptune is brightest at sunspot minimum, which occurs at the same time as the cosmic ray flux maximum.

The proponents of solar-induced climate change have not been able to formulate a precise physical mechanism to explain the observed correlations, so the global climate modellers have had difficulty including such effects in their already-complex numerical models. There appears to be a gulf of misunderstanding between various groups studying climate change, and much needs to be done to test the hypotheses and clarify the issues. Pål Brekke's summary comments say it all: "Whether the global warming trend recently measured is dominated by anthropogenic effects or has a significant or even dominant solar component is not yet fully understood. The climate of the future will be the sum of man-made and natural variations, but the man-made part cannot be estimated reliably until the contributions of natural agents (Sun, volcanoes, El Niño) have been defined and subtracted from the observed changes of the past 100 years."

Canadian Comet Catchers: an Update

Congratulations to Vance Petriew of the Regina Centre for his discovery of Comet Petriew (C/2001 Q2) at the Saskatchewan Summer Star Party in Cyprus Hills in August. After a long string of comet discoveries by spacecraft-based instruments, finally an amateur astronomer visually discovers a comet using his own telescope at a star party in Canada. How refreshing! This naturally caused great excitement among Canadian amateur astronomers, and there was much discussion on the RASClist about the current discovery and past discoveries by Canadians. I was inspired to dust off my October 1999 *Reflections* column on Canadian comet discoveries and update the information. This time, I decided to create a Web page, which is easily amended and updated. The URL for Canadian Comet Catchers is `www3.ns.sympatico.ca/dave.chapman/CanCom.html` (there is also a link from my astronomy page below). Please visit and tell me what you think. Both Vance Petriew and Ed Majden helped me out with some of the details, along with many of the comet catchers themselves. I could use more anecdotes and images, if there are any out there.

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`

First Landing on an Asteroid

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

In yet another demonstration that real life often outpaces science fiction, the year 2001 is remarkable for the first landing of a spacecraft on an asteroid (see September 27, 2001 issue of *Nature*). If memory serves me correctly, that had not yet happened in Arthur C. Clarke's *2001: A Space Odyssey*. Joseph Veverka of Cornell University and a large team of colleagues, including Peter Thomas (also of Cornell) and Mark Robinson (of Northwestern University) found some surprises as the NEAR-Shoemaker spacecraft descended gently towards Eros on February 12 of this year.

Although NEAR-Shoemaker's original mission profile had it only orbiting the asteroid for a year, managers decided to attempt a controlled descent. It took about 4.5 hours for the spacecraft to descend from its ~35 km orbit, during which time 70 images were obtained by the on-board camera. These images provide our best look ever at the surface of an asteroid, with an amazing resolution of 1.2 cm per pixel achieved at an altitude of 129 metres. Although the camera stopped functioning on impact, another instrument continued transmitting data for days afterwards.

An artist's impression of NEAR-Shoemaker approaching Eros, courtesy of NASA/Johns Hopkins University Applied Physics Laboratory.

Eros is the second largest known near-Earth asteroid, with dimensions of about 34×13×13 km. It began its life in the main asteroid belt, but migrated towards the Sun under the influence of continual pounding by other asteroids and a variety of gravitational interactions of which Jupiter is the most important contributor. Once an asteroid arrives in the inner Solar System, it typically has a lifetime of about 10 million years. After that time the orbit is sufficiently changed to put the asteroid on a path where it hits either the Sun or a planet, or it may be ejected from the Solar System. One of the planets that could be hit is, of course, the Earth. This possibility has prompted a lot of research into the orbits and properties of asteroids. Eros has been estimated to have a 5% chance of hitting the Earth during the next 50–100 million years (posing no immediate danger!).

The most striking observational results are a lack of small craters, an abundance of large 'blocks' that appear to be ejecta from a large crater, and a very smooth surface at the smallest scales. The absence of small craters and the presence of the smooth 'ponds' are related because of the nature of the surface. Until relatively recently, asteroids were thought to be solid chunks of rock whose surfaces had been blasted by smaller asteroids and rocks over the history of the Solar System. It was argued that as the surface gravity of asteroids is very small, even a small impact would eject any loose material into space. In the past ten years, theoretical and observational evidence has accumulated that at least some small asteroids (smaller than Eros) are simply 'rubble piles,' rather than solid bodies. The data from the NEAR-Shoemaker images show that our earlier thoughts on larger asteroids are wrong, too. Obviously, processes occur that lead to the accumulation of a substantial regolith, which is simply crushed rock like mineral soil. The ground-up rock appears to fill in areas on Eros to a pond-like smoothness, by mechanisms we do not yet understand. Even areas less smooth than the ponds have accumulated enough loose material to erase small craters and inhibit the formation of new ones, just as it is difficult to form and keep an impact crater in loose sand on Earth. No analogues of these ponds have been seen on the Moon.

Thousands of 'blocks' — hundreds bigger than 30 m in size — were found to the northeast of the landing site. Many of them are in a relatively young crater tentatively dubbed 'Shoemaker,' in honour of Gene Shoemaker's landmark insight that many craters on the Earth are the result of impacts rather than volcanism. Many of the rest are in a spray pattern around the equator of the asteroid. Modeling of impacts of sufficient size to make the crater indicate that most of them came from that one impact. This means that most of the blocks and ejecta from previous impacts have been buried or eroded, which in turn implies a rather rapid processing of the surface.

One possible way to move the fine grains of rock around the surface is through electrostatic effects. If sub-micron-sized grains were ionized by sunlight, then electrostatic levitation could have moved them around until they settled — like water — in low spots. If this is correct, it could pose a real problem for future, more ambitious, landers. Even on the Moon, where the gravity is substantial compared to the surfaces of asteroids, dust was still a bit of a problem for the astronauts.

These new data have implications for attempting to intercept or deflect asteroids headed towards Earth, in that they make the response of such an asteroid much more difficult to predict (see Erik Asphaug's *News & Views* in the same issue of *Nature*). There have been suggestions that firing large rocks at high speed would deflect an asteroid's path sufficiently to nudge it away from Earth, or exploding thermonuclear bombs nearby would blast it to pieces, but now there is no telling how a body with a soft surface like Eros might react. Asteroids have turned out to be much more subtle and interesting than we imagined only a few years ago.

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.*

JOURNAL PRODUCTION MANAGER POSITION AVAILABLE

Following notice of the resignation of Dave Lane (the current Production Manager), effective at the completion of the June 2002 issue, the Publications Committee seeks to fill the volunteer position of Production Manager for the *Journal.*

The Production Manager's primary responsibilities are to:

- Coordinate the production of the *Journal*, and act as a liaison between the Editor and editorial staff, and the Graphic Designer while ensuring the production schedules are met.
- Ensure adherence to the *Journal.* graphic design style (editorial style adherence is the responsibility of the Editor).
- Receive issue material from the Editor, provide quality control of text and graphics, locate or create graphics as needed, and send a comprehensive package of material to the Graphic Designer.
- Resolve problems and makes production decisions as required. Send proofs to the Editor and Research Paper authors. Proofread the entire issue for correct graphic style. Ensure the proofreader, editor, and author corrections are incorporated correctly. Approve final proofs. Approve Dylux film proofs.
- Perform a variety of other administrative and post-issue tasks.

For a detailed job description of the position, see the *Journal.* web page at: `www.rasc.ca/journal`. For further information, to express interest in the position, or if you know someone that we should contact who might be interested, please contact the chair of the Publications Committee, Rajiv Gupta at `gupta@interchange.ubc.ca`.

Research Papers
Articles de recherche

THE EFFECTIVENESS OF THE CANADA-FRANCE-HAWAII TELESCOPE

by Dennis R. Crabtree

Canadian Gemini Office, Herzberg Institute of Astrophysics
Electronic Mail: Dennis.Crabtree@nrc.ca

and Elizabeth P. Bryson

Canada-France-Hawaii Telescope
Electronic Mail: bryson@cfht.hawaii.edu

(Received July 25, 2001; revised August 27, 2001)

Abstract. We have investigated the productivity and impact of the Canada-France-Hawaii Telescope (CFHT) during its twenty-year history. CFHT has maintained a database of refereed publications based on data obtained with CFHT since first light in 1979. For each paper, we analyzed the cumulative number of citations and the citation counts for each year, from data supplied by the NASA Astrophysics Data System (ADS). We have compared citation counts retrieved from the ADS with those from the Institute for Scientific Information (ISI) for a small sample of papers. We have developed a procedure that allows us to compare citation counts between older and newer papers in order to judge their relative impact. We looked at the number of papers and citations not only by year, but also by the instrument used to obtain the data. We also provide a preliminary look as to whether programs given a higher ranking by the Time Allocation Committee (TAC) produced papers with a higher number of citations.

Résumé. Nous avons analysé la productivité et l'impact du télescope Canada-France-Hawaii (CFHT) durant les vingt années depuis sa construction. Une collection de publications revues par un comité de lecture, dans lesquelles on retrouve les études basée sur les données obtenues à l'aide du télescope, est maintenue par le CFHT depuis sa première lumière en 1979. Pour chaque étude, nous avons analysé le nombre cumulatif de citations et le compte annuel de citations puisé dans la base de données astrophysiques de la NASA (ADS). Nous avons comparé le nombre de citations dans le ADS avec celui tiré de la base de données analogue de l'Institute for Scientific Information (ISI) pour un petit échantillon d'études. Nous avons dévelopé une procédure qui nous permet de comparer les citations tirées d'études des années passées et plus récentes pour en juger leurs impacts relatifs. Nous avons examiné un nombre d'études et de citations non seulement par année, mais aussi par le télescope utilisé pour obtenir les données comprises dans ces études. Nous présentons aussi un aperçu préliminaire de notre évaluation de la possibilité que les programmes ayant un rang plus élevé selon le Time Allocation Committee (TAC) a produit des études avec un plus grand nombre de citations.

1. Introduction

Astronomers use telescopes to investigate a wide range of scientific problems with almost as diverse a range of instrumentation. The output from these investigations provides an immense amount of data that needs to be reduced and analyzed. The results from the investigation are published in scientific journals, and these papers have an impact, small or large, on future observational and/or theoretical investigations.

Two measures of the effectiveness of a telescope are the number of papers published in refereed journals that are based on data obtained by the telescope, and the citation count of those papers. The effectiveness, or lack therein, of a telescope can have far-reaching consequences. For example, in Canada the effectiveness of a single major telescope, the Canada-France-Hawaii Telescope (CFHT), may have a significant impact on the funding of future telescopes. Abt (1985) compared the impact of two facility telescopes (the CTIO and KPNO 4–m) with that of two telescopes run by private observatories (the Lick 3–m and the Palomar 5–m). He found no significant difference. Trimble (1995) compared the impact of large US optical telescopes for papers published in 1990–1991. More recently Benn & Sánchez (2001) compared the scientific impacts of telescopes world-wide based on their contributions to the 1000 most-cited papers (1991–98) and the number of papers published in *Nature* between 1989–1998. They found that CFHT was the most productive and most highly cited of all 4–m class telescopes during this time period.

Productivity, as measured by the number of papers, and impact, as measured by citation numbers, are the two measures we will use to assess the effectiveness of the CFHT over its approximately twenty-year history. Simply counting the number of papers in refereed journals is an easy way to measure effectiveness, but misses completely the influence these papers have on the field. It should be noted, that citation numbers are not a perfect measure of a paper's impact, nor are they necessarily a measure of the paper's scientific value. In this contribution, we will examine the productivity and impact history of CFHT papers. We will also examine the productivity and impact of the various instruments that have been used at CFHT during its twenty years of operation. Finally, we will look at how the citation counts for published papers are related to the grade assigned the original observing proposal by the Time Allocation Committee.

2. The Data

CFHT maintains a database of publications in refereed journals that are based on data obtained with the telescope. The database contains information on 1065 papers published between 1980–1999. Papers are identified from four main sources: reprints submitted by authors, scanning of all major journals, observers' time request forms, and searching NASA's Astrophysics Data System (ADS) for papers referring to CFHT in the abstract. The following criteria are used to judge whether a paper is considered a CFHT publication:

> A paper must report new results based on significant observational data obtained at CFHT or be based on archival data retrieved from the CFHT archive. If data from multiple telescopes are included, the CFHT data should represent a significant fraction of the total data.

A staff astronomer examines each paper to judge whether it meets these criteria. Although an author may footnote a paper to indicate that it is based on CFHT observations, the paper may not meet the criteria for inclusion in the database. In our view, this rigorous emphasis on validation of all papers by astronomers within CFHT makes the database unique.

The CFHT publication information is maintained within a Microsoft Access database. Several routines, written in Visual Basic for Applications within the database, query the ADS for information on each publication. These routines utilize an Internet Data Transfer Library (Ashish & Kreft 1998) downloaded from the Internet. The software generates the appropriate query as a URL, sends the URL to the ADS, and parses the returned text to extract the relevant information. The information for each publication in the ADS is accessed by a publication bibliography code, bibcode, which is generated from the year, journal, volume, and page information for a publication. One of the many services ADS provides is a verification utility that returns a yes/no as to whether a particular bibcode is valid. For each entry in our database, the ADS bibcode is generated from the publication information and verified with the ADS. The information for those entries with invalid bibcodes is checked and updated; then a new bibcode is generated and verified. This verification of each paper's bibcode ensures that we have the correct publication information for each entry. Once each publication has a valid bibcode, the ADS is queried for the full title, list of authors, the number of citations and the number of self-citations (ones in which the first author of the cited and citing paper are the same person). Finally, the bibcodes of each citing paper, and the number of citations by year, of the citing paper, are recorded for each publication. The instrument, or instruments, used to acquire the data used for each publication was identified by browsing each of the papers.

This use of the ADS allows us to verify the basic bibliographic information, obtain a complete list of authors, and collect the citation data for each publication. The citation information in the ADS is incomplete (Kurtz *et al.* 2000). Much of the citation information in the ADS is based upon a subset of the Science Citation Index purchased from the Institute for Scientific Information (ISI) by the ADS. This subset is seriously incomplete in referring to articles in the non-astronomical literature, as it only contains references that were in the ADS when the subset was purchased. The ADS currently builds citation links for all publications in its database. The ADS does not include many physics journals, but does include a subset of conference proceedings.

2.1 Comparison of ISI and ADS Citation Counts

ISI, an established and reputable commercial firm, has been considered the best resource for citation information among astronomers and librarians for many years. However, the ADS provides publication and citation information from the Web at no cost to the end user. How does the citation information obtained from these two sources compare? We selected three highly cited CFHT papers: Carlberg *et al.* (1996); Cowie *et al.* (1996); Lilly *et al.* (1996), and performed a detailed analysis of citations to these papers using both the ADS and ISI (through the online service DialogWeb). While the total number of citations to the three papers from ISI/ADS are remarkably similar (146/153, 125/124, 172/177), there are interesting differences in the details of the citing papers. The number of citing papers in common to ADS and ISI for the three papers is 142, 109, and 165. Each database missed several citing papers that the other one included. ISI tended to find citations from physics journals missed by ADS, while ADS had some conference citations and citations from the major journals that were missed by ISI. The citing papers in the major journals were missed by ISI primarily due to incorrect citations (*e.g.*, wrong year or volume) in the citing papers. Our conclusion from this detailed look at a small number of papers is that, on average, the ADS provides citation numbers that are consistent with those obtained from ISI and any differences will have a minimal impact on our study.

3. CFHT's Productivity and Impact

We define two terms that we will use throughout the rest of the paper: productivity and impact. Productivity refers to the number of publications in the context of the telescope, an instrument or a particular researcher. Productivity is not the same as scientific impact. Impact is usually measured by using citation numbers. Overall impact is measured by summing citation numbers of all the relevant papers. The average number of citations per paper (CPP) measures the average impact.

3.1 Citation Histories

For each entry in the CFHT database, we have retrieved the year of every citing paper and stored the total number of citations for each year in the database. A paper published in 1990, for example, has the number of citations received for each year from 1990 to 1999. These data allow us to investigate the citation rate as a function of the number of years since publication. The solid curve in Figure 1 shows the average citations per paper as a function of the number of years

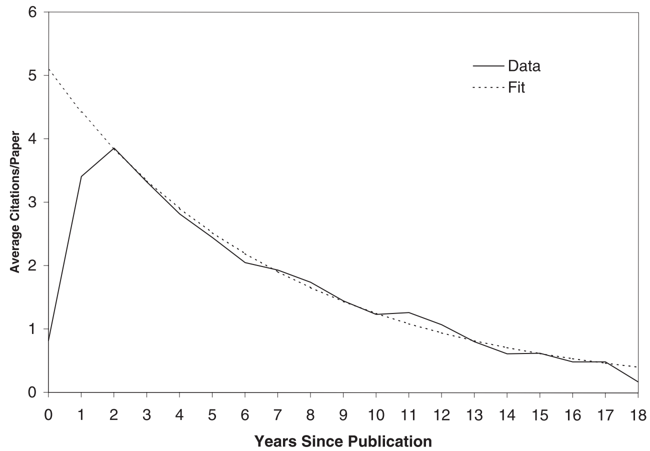


Fig. 1 — The average citation rate as a function of the number of years since publication. The solid line is the data for all CFHT papers and the dashed line is the fit of a simple exponential decline with a half-life of 4.93 years.

after publication for all papers in the database with citations. There are some citations in the year of publication for papers published early in the year; for example, a paper published in January may receive a citation in November. As the number of years since publication increases, the number of papers included decreases since the relevant data for all papers do not yet exist. The papers published in 1999 are included in only the data point for zero years after publication, and 1998 papers are included in the zero and one year data points, *etc.* This curve peaks at two years after publication and has a fairly smooth decay after that. It has been known for many years that the number of citations a paper receives declines exponentially with the age of the paper (*e.g.,* Burton & Kebler (1960)). This is true of CFHT publications as well. The dashed line in Figure 1 is the fit of a simple exponential decline in citations with a half-life of 4.93 years beginning two years after publication.

Our analysis does not include a correction for a growth in publication numbers over the period 1982–1999. Abt (1981) found a half-life of around twenty years for papers published in the 1961 issues of *ApJ*, *ApJS*, and *AJ*. However, he pointed out that the growth in the number of papers published over the eighteen-year period, for which he gathered citation numbers was part of the reason the half-life was so long. Peterson (1988) shows that the number of papers published in those three journals increased by 4.6 times over this period. Kurtz *et al.* (2000) show that the number of papers in the "Big 8" journals (*ApJ, ApJL, ApJS, A&A, A&AS, MNRAS, AJ*, and *PASP*) increased at approximately a 3.7% yearly rate between 1976 and 1998. Astronomical literature has doubled between 1982 and 1999, the years covered in our study.

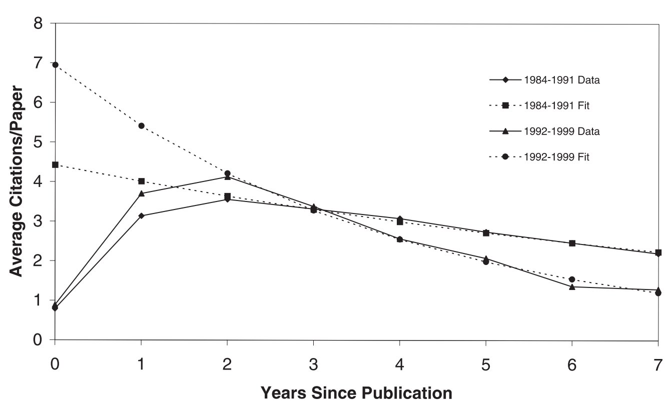


Fig. 2 — The average citation rate as a function of years since publication for CFHT split into two groups: 1984-1991 papers and 1992-1999 papers.

Has the electronic distribution of preprints and journal articles changed the citation history of papers? To examine this question, we divided the CFHT papers into two groups: those published between 1984 and 1991, and those published between 1992 and 1999. There were 428 and 522 papers in these two groups. In Figure 2 the average citation rate for these two periods is shown along with the fit of a simple exponential model for each period. The citation rate for the newer papers clearly declines more rapidly than that of the older papers. The half-life of the older papers is 7.11 years while the half-life for the newer papers is 2.77 years. We believe that if one were able to sample citation rates monthly, the citations for an average paper in the more recent dataset would peak less than two years after publication. This is the result of more rapid dissemination of results by the electronic distribution of pre-prints (*astro-ph*) and journal articles. The faster decline in citations for the recent subset also indicates that new results supersede earlier results more quickly than in the past.

3.2 Comparing Papers from Differing Years: A Standard Citation Measure

Comparing the citation numbers for papers published in different years is difficult since the number of citations to a paper increases with time. We have established a method for estimating the total number of citations that a paper can be expected to achieve after a suitably long period. How do we compare papers published over almost twenty years, given the natural growth in citations with time? We have used the average citation history of all CFHT papers to define a growth curve for citations (Figure 3). This curve shows the percentage

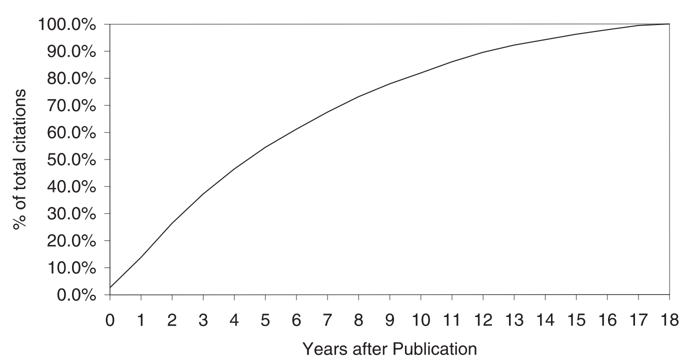


Fig. 3 — Citation count growth curve for all CFHT publications.

of the final number of citations, defined as the number eighteen years after publication, for an average paper versus the years since publication. Using this curve, we can estimate the final citation count (FCC) for each paper given a citation count and the number of years since publication.

4. Productivity and Impact History

The first CFHT paper was submitted in May 1980 and was published in August of that year (van den Bergh 1980). CFHT's productivity

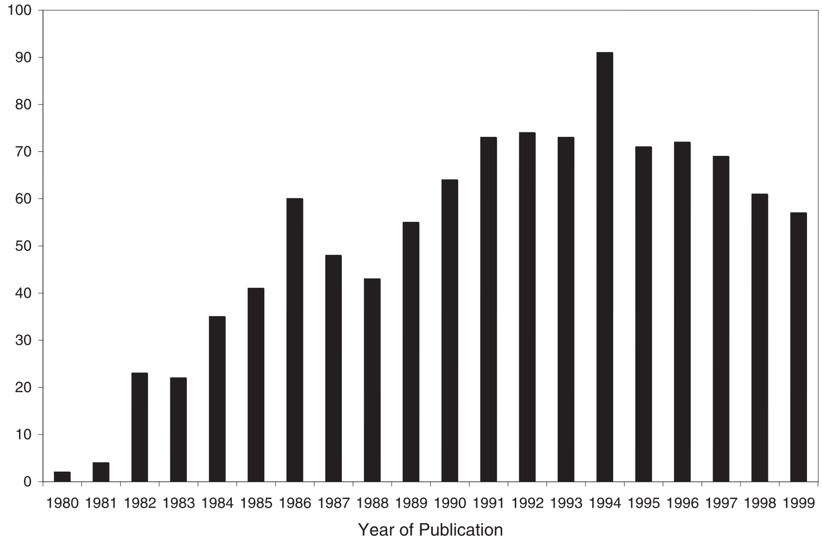


Fig. 4 — Number of CFHT Papers by Year of Publication.

(Figure 4) rose more or less continuously through the 1980s until it reached a fairly constant level of around seventy-five papers per year between 1991 and 1997. It took approximately ten years for CFHT to hit its stride and reach a consistently high level of paper production. A telescope's productivity in any one year is linked to many factors such as weather, competitiveness of the available instruments, and the reliability of instruments and the telescope, all in the several years before the year of publication. We attribute the increase in publications during the first ten years of CFHT to the increase in the reliability of both the instruments and the telescope and to the development of more competitive instruments. There are two possible reasons the number of CFHT publications may be in a slow decline. First, as more 8–10 meter telescopes come on-line, CFHT is no longer a forefront facility. Second, the use of large mosaic CCD cameras has increased at CFHT. These generate a tremendous amount of data, and the time from acquisition of data to the publication of results has likely increased.

Trimble (1995) studied the productivity of large American optical telescopes including CFHT. She compiled publication data for an eighteen month period beginning January 1990, by examining the major North American journals: *ApJ, ApJL, ApJS, AJ, PASP*. According to Trimble's list, CFHT ranked fourth in productivity behind the CTIO 4–metre, Palomar and the KPNO 4–metre; and, as Trimble notes, many CFHT publications appear in journals not included in her study. Taking all of the 1990 papers and half of the 1991 papers, we count sixty-seven CFHT papers (Trimble counted 58.6) that were published in the major North American journals during this period. (Trimble pro-rated each paper based upon the number of telescopes used in the paper, which we have not done.) Our database contains one hundred and one CFHT papers published in *all* refereed journals during this period. If we correct this number by the same factor that our earlier number differs from Trimble's for only North American journals, we end up with a total of 88.3 papers. The total number of CFHT publication changed significantly by including publications from all journals. While the other telescopes undoubtedly had publications in non-North American journals, except for the Anglo-Australian Telescope, their numbers would not have increased as significantly. Thus, any future study of papers and citations, especially those that compare different facilities, should include all major journals. The average CPP for all papers in a given year, by year of publication, is shown in Figure 5. One would expect the average CPP to grow smoothly with time since publication. However, due to the relatively small number of papers in any given year, the average CPP can be influenced by a small number of highly cited papers. For example, the bump in 1996 is due to two highly cited papers (Lilly *et al.* 1996, Carlberg *et al.* 1996) that are based on data taken with MOS, the Multi-Object Spectrograph. The fluctuations in citation numbers are much higher in earlier years when the number of papers was smaller.

4.1 Publications and Citations by Journal

Most CFHT observers are from Canada, France, or the University of Hawaii (UH). The French tend to publish in European journals, mainly *A&A*, while Canadian and UH researchers favour North American journals. How are CFHT publications distributed across the major journals? The distribution of publications across eight journals (we include *ApJL* with *ApJ*) is shown on the left side of Table I. In addition, each paper has been tagged as belonging to one of the three partners based upon the affiliation of the first author or the agency that granted time for the observations. (Canada grants some time to international researchers.) The majority of CFHT papers have been published in the three major journals — *ApJ, A&A*, and *AJ* account for more than 78% of CFHT papers.

ApJ has the most publications with 33% of all CFHT publications, while *A&A* receives 25.8% of the publications. The breakdown of publications by journal for different years shows an interesting change. In 1996/1997 33% and 25% of papers were published in *AJ* and *A&A* respectively, while for 1998/1999 the numbers were 25% and 45%. One explanation for this change is that the French are publishing more and the Canadians/UH less in recent years. Only 75 (18.9%) of the French papers appeared in American journals while only 53 (9.7%) Canadian papers, and 6 UH papers (5.1%), appeared in non-North American journals. There is a very strong trend for European authors to publish in European journals and North American authors to publish in North American journals. This may be a result of the fact that *A&A* has no page charges for European authors, and subsequently, the

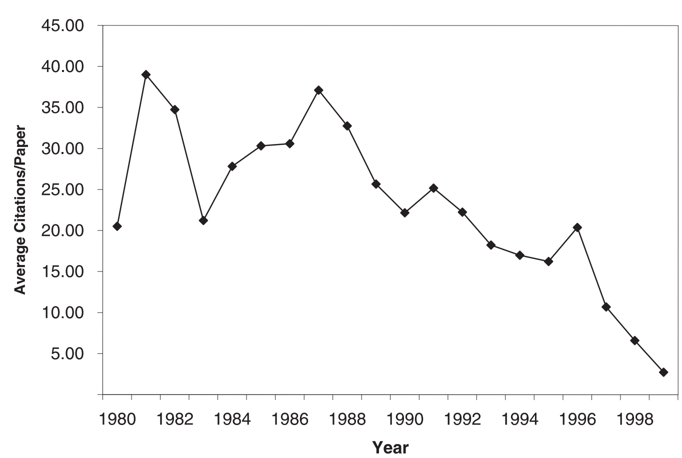


Fig. 5 — The average citations per paper (CPP) for all papers published in a given year.

Table I Distribution of Papers and Citations by Journal

Journal	Number of Papers All	C	F	H	Citations/Paper All	C	F	H
A&A	275	34	239	2	14.86	8.79	15.82	4.00
A&AS	37	4	32	1	11.92	4.25	12.91	11.00
AJ	209	174	10	25	18.70	18.06	15.00	24.64
ApJ	351	223	59	69	29.73	29.20	22.34	37.77
ApJS	22	18	1	3	28.00	30.28	2.00	23.00
MNRAS	20	10	10	0	9.25	11.90	6.60	0.00
Nature	18	5	9	3	33.72	47.20	19.89	64.00
PASP	82	66	5	11	11.02	11.33	7.60	10.73
Total/Average	1065	549	397	117	20.35	21.42	15.75	31.30

French do not have a large budget for page charges. This tendency for authors to publish on their "side" of the Atlantic Ocean is particularly meaningful for any comparison of publication activity levels between North American (only) and multinational observatories. The distribution of citations per paper across the journals is shown in Table I. The three major journals, *ApJ* (including the Letters), *A&A*, and *AJ*, account for 84.7% of the citations to CFHT papers. While *ApJ* papers account for 33% of the CFHT total, these papers received almost half (48.1%) of the citations. *A&A, A&AS, AJ, MNRAS*, and *PASP* all have a citation rate lower than the average CPP of 20.35. *Nature* has the highest CPP of any journal (2.8%), and yet these represent only 1.6% of CFHT papers.

4.2 Publications and Final Citation Count by Instrument

The primary instrument used to acquire the data was identified for each publication. In a few cases, several instruments were grouped together into a single category. For example, FP refers to several different "Fabry-Perot" instruments, Coudé refers to the two Coudé spectrographs that have been used at CFHT, and "Direct Imaging" combines several different direct imaging cameras that have been used at CFHT over the years. HRCam (McClure *et al.* 1989), which incorporated fast tip-tilt correction, and MOCAM (Cuillandre *et al.* 1996) and UH8K (Metzger, M. R., Luppino, G. A., & Miyazaki, S. 1995), two mosaic cameras, are identified separately from other direct cameras because they represent new technologies, and we wish to track their impact directly. A total of 39 distinct instrument or instrument categories were identified; however, a large number of instruments produced a very few papers and approximately 70% of CFHT papers were produced by the top five instrument/instrument categories. Table II shows the number of papers, the FCC per paper, and the FCC per night of scheduled telescope time for the top-ten paper producing instruments. The number of nights of scheduled telescope time was determined by looking at each semester's schedule from 1982 onward and counting the number of nights for each instrument/instrument group. CFHT is known for its exceptional image quality, and it is no surprise that direct imaging has produced the highest number of papers. It also has the highest efficiency of turning scheduled nights into citations. The two Coudé spectrographs and the Multi-Object Spectrograph (MOS) produced the 2nd and 3rd highest number of papers. The CFRS (Lilly *et al.* 1996) and CNOC (Carlberg *et al.* 1996) studies are a large contributing factor to the high impact of MOS.

5. CFHT's Prolific Authors

Who have been the most prolific authors over the twenty years of CFHT publications? Table III shows the top nine most prolific authors with the total number of publications, the number of publications in four of the major journals, the total number of citations to their papers,

Table II Papers and Citation by Instrument

Instrument	Papers	Papers/night	FCC/paper	FCC/Night
Direct Imaging	358	0.36	35.47	12.86
Coudé Spectrograph	169	0.25	28.37	6.97
Multi-Object Spectrograph	75	0.19	48.38	9.92
Fourier Transform Spectrometer	64	0.16	17.28	2.70
Hrcam[a]	49	0.24	27.60	6.61
Herzberg Spectrograph	34	0.24	29.11	6.86
Fabry-Perot	24	0.16	19.84	3.11
Adaptive Optics near-IR imaging	21	0.21	20.76	4.45
SIS[b]	18	0.12	26.82	3.24

[a]tip-tilt stablized imager
[b]tip-tilt stablized imager/spectrograph

Table III CFHT's Most Prolific Authors

Author	Papers					Citations		
	Total	ApJ	A&A	AJ	PASP	Total	per Paper	FCC
Hutchings, J.	38	6	0	21	8	909	23.9	1106
Davidge, T.	35	12	0	19	1	310	8.9	492
Nieto, J-L.	16	11	0	1	0	282	17.6	333
Le Fèvre, O.	15	3	9	0	0	333	22.2	525
Kormendy, J.	14	12	2	0	0	719	51.4	1024
Boesgaard, A.	13	1	0	0	3	577	44.4	682
Crampton, D.	13	3	1	7	2	200	15.4	239
Richer, H.	13	10	1	0	0	423	32.5	515
Harris, W.	12	3	6	2	0	389	32.4	513

their average CPP, and their projected FCC, assuming they publish no more papers based on CFHT data. The most prolific authors have favoured North American journals. The two French authors in this list have 45% of their papers in North American journals as compared to only 18.9% of all papers designated as French. Citations will be discussed more thoroughly in the next section. However, it is clear that the average CPP for these authors varies significantly.

5.1 Self-Citations

The issue of self-citations (ones where the first author of cited and citing paper are the same) is one frequently asked of (and discussed by) librarians. What is the average self-citation rate? As Trimble points out, this number is difficult to determine exactly. Authors do not always use a consistent name (first name or first initial, for example), which may lead to the incorrect counting of self-citations. We have counted self-citations for CFHT papers by matching first authors on the cited and citing papers. The average self-citation rate for all CFHT papers is 6.3%. On average, corrections to citation numbers for self-citations are not important. However, the self-citation rate for individual papers can be much higher. There are almost ninety papers with a self-citation rate of 30% or more, and many of these have ten or more citations. Also, certain authors tend to favour their own work. Several authors with four papers or more have average self-citation rates of 20% or higher. Highly cited papers had much lower than average self-citation rates. The twenty most cited papers in the database have an average self-citation rate of 3%, less than half of the average rate for all papers.

Table IV CFHT's Most Highly Cited Papers

Authors	Title
Lilly et al. (1995)	The Canada-France Redshift Survey. VI. Evolution of the GalaxyLuminosity Function to $Z \approx 1$
Lilly et al. (1991)	A Deep Imaging and Spectroscopic Survey of Faint Galaxies
Lilly et al. (1996)	The Canada-France Redshift Survey: The Luminosity Density and StarFormation History of the Universe to $Z \approx 1$
McCarthy et al. (1987)	A Correlation Between the Radio and Optical Morphologies of Distant 3CR Radio Galaxies
Carlberg et al. (1996)	Galaxy Cluster Virial Masses and Omega
Spite & Spite (1982)	Abundance of Lithium in Unevolved Halo Stars and Old Disk Stars — Interpretation and Consequences
Cowie et al. (1996)	New Insight on Galaxy Formation and Evolution From Keck Spectroscopy of the Hawaii Deep Fields
Kormendy (1985)	Families of Ellipsoidal Stellar Systems and the Formation of Dwarf Elliptical Galaxies
Tyson et al. (1990)	Detection of Systematic Gravitational Lens Galaxy Image Alignments — Mapping Dark Matter in Galaxy Clusters
Pierce et al. (1994)	The Hubble Constant and Virgo Cluster Distance from Observations of Cepheid Variables

6. CFHT's Most Highly Cited Papers

We computed the final citation count for each CFHT paper in the database using the growth curve described above. The ten papers with the highest FCC are listed in Table IV. It is interesting to note that the top three papers in this list have the same first author, Simon Lilly. Lilly also has the highest total FCC, summed over all papers, of any author in the CFHT database. Two of the top three papers are based on data from a large, ambitious project undertaken with a new forefront instrument. The top three papers all have the word "survey" in their title as well.

7. How Effective is the Time Allocation Committee?

The observing time requested by proposals to use any large telescope such as the CFHT generally outnumbers the available time by a significant factor. A Time Allocation Committee (TAC) is established to review and to rank the submitted proposals, and, in classical scheduling, only the highest-ranked proposals make it to the telescope. However, in queue scheduling, the relative ranking of the proposals will be an important factor in determining which programs are actually executed. The role of the TAC becomes even more critical in the era of queue scheduling. How effective is the TAC in judging the scientific merit of proposals? Most would agree that almost all programs that reach the telescope will likely produce a scientific publication if the weather and the equipment co-operate. However, one would expect that the more highly ranked proposals will, on average, produce

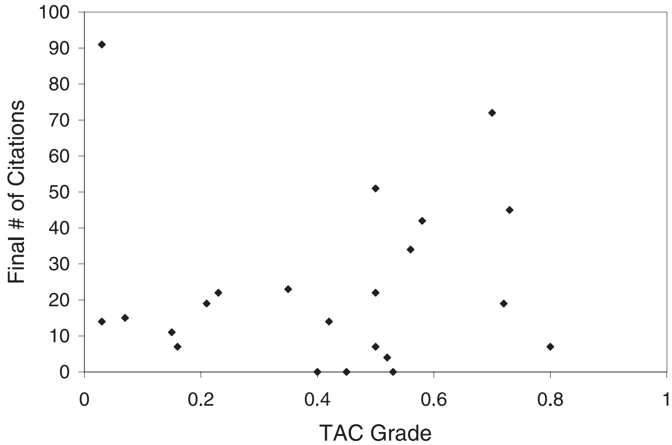


Fig. 6 — The predicted final number of citations versus the Time Allocation Committee (TAC) grade assigned to the original proposal for a subset of CFHT publications. A lower TAC grade is "better." The highest ranked proposal will have a TAC grade near 0.0, while proposals that just make it on the schedule have a grade of 1.0. Note the single point with a very high TAC grade and a predicted high number of citations.

publications with a higher impact, *i.e.*, number of citations. We feel this evaluation of the TAC process is important as several large telescopes undertake queue scheduling.

Observing time at CFHT is allocated by country: 42.5% for each of Canada and France, and 15% for the University of Hawaii. Each country runs its own TAC, which assigns the grades. The International TAC meets to deal with scheduling conflicts and program overlaps. We have identified the original proposal associated with twenty-two CFHT papers published between 1997 and 1999. One of us (D.C.) has access to the TAC ranking for these proposals as he served as Senior Resident Astronomer for three years. We are thus able to look at the correlation between the TAC ranking of the proposal and the predicted FCC for the papers resulting from those observations. We selected only those papers that were based on a proposal that used only data from CFHT and data from a single observing run. Figure 6 shows the FCC versus TAC ranking (a small number is a higher ranking) for these twenty-two proposals. Except for one highly ranked, highly cited study, there is a weak inverse correlation from a simple linear fit to the data. Another interpretation of the data is that highly-ranked studies (< 0.4) show small scatter around a constant number of citations, while lower-ranked studies show a much larger scatter. Is the TAC being conservative and ranking sure bets higher while riskier studies end up with lower rankings? We want to emphasize that this result is very preliminary, as only twenty-two papers are included, and it relies on the predicted final citation counts. We found no dependence of the FCC on the number of nights of telescope time awarded for the same twenty-two programs.

8. Conclusions

We have studied the productivity and impact of the CFHT over its twenty-year history by looking at the number of papers in refereed journals and the number of citations to these papers. It took ten years for CFHT to achieve and maintain a high level of paper production. We attribute this to a fairly long commissioning period for the telescope and the time to develop a competitive suite of instrumentation. Direct imagers (photographic plates, CCD imagers) have been CFHT's most productive instruments, both in the number of papers and the number of papers per night of scheduled telescope time. The excellent image quality at CFHT is a significant factor in direct imaging's high productivity.

We retrieved citation counts and the years of the citing papers from the ADS for all CFHT papers in our database. Using these data, we developed a procedure for estimating the number of citations that a paper can be expected to receive after a period of almost twenty years. This estimation allowed us to compare the citation numbers for papers from different years and to compare the impact of different instruments. The instrument that produced the papers with the highest impact (average citations/paper) was the Multi-Object Spectrograph (MOS), which was used in the highly cited CFRS and CNOC studies. Direct imaging had the second highest impact. In looking at the number of citations/night of allocated time, direct imaging had the highest impact, followed by MOS and the two Coudé spectrographs. The efficiency of converting observing nights into papers or citations varies considerably between instruments. For example, there is a factor of five difference in the average final citation count per night between Direct Imaging and the FTS. In order to maximize a telescope's impact, one might consider offering only the "high-efficiency" instruments.

Finally, a look at the correlation between the predicted final citation count and the TAC ranking of the observing proposal showed a weak negative correlation, *i.e.*, lower-ranked proposals end up with a higher number of citations. An alternative interpretation has higher-ranked proposals with a lower number of citations with a small scatter. Lower-ranked proposals have more scatter in the number of citations, and some of these end up with significantly more citations than most of the higher ranked proposals.

Acknowledgments

We acknowledge the Canada-France-Hawaii Telescope and the Herzberg Institute of Astrophysics for their support of this project. We thank Pierre Couturier for his impetus in initiating the analysis of CFHT publications. We also thank Gordon W. Bryson for his editing and Virginia Smith for her assistance during her mentorship at CFHT. This research has made use of NASA's Astrophysics Data System Bibliographic Services.

Dennis R. Crabtree
Canadian Gemini Office
Herzberg Institute of Astrophysics
National Research Council Canada
Victoria, BC V9E 2E7
Canada

Elizabeth P. Bryson
Canada-France-Hawaii Telescope
Kamuela, HI 96743
U.S.A.

References

Abt, H.A. 1981, PASP, 93, 207

Abt, H.A. 1985, PASP, 97, 1050

Ashish, D., & Kreft, T. 1998, www.mvps.org/access/modules/mdl0037.htm

Benn, C.R., & Sánchez, S. F. 2001, PASP, 113, 385

Burton, R.E., & Kebler, R.W. 1960, American Documentation, 11, 18

Carlberg, R.G., Yee, H., Ellingson, E., Abraham, R., Gravel, P., Morris, S., & Pritchet, C.J. 1996, ApJ, 462, 32

Cowie, L.L., Songaila, A., Hu, E.M., & Cohen, J.G. 1996, AJ, 112, 839

Cuillandre, J.-C., Mellier, Y., Dupin, J.-P., Tilloles, P., Murowinski, R., Crampton, D., Wooff, R., & Luppino, G.A. 1996, PASP, 108, 1120

Kormendy, J. 1985, ApJ, 295, 73

Kurtz, M. J., Eichhorn, G., Accomazzi, A., Grant, C.S., Murrray, S.S., & Watson, J. M. 2000, A&AS, 143, 41

Lilly, S.J., Cowie, L.L, & Gardner, J.P. 1991, ApJ, 369, 79

Lilly, S.J., Tresse, L., Hammer, F., Crampton, D., & Le Fèvre, O. 1995, ApJ, 455, 108

Lilly, S.J., Le Fèvre, O., Hammer, F., & Crampton, D. 1996, ApJL, 460, L1

McCarthy, P.J., van Breugel, W., Spinrad, H., & Djorgovski, S. 1987, ApJL, 321, 29

McClure, R.D., Grundmann, W.A., Rambold, W.N., Fletcher, M.J., Richardson, E. H., Stilburn, J.R., Racine, R., Christian, C.A., & Waddell, P. 1989, PASP, 101, 1156

Metzger, M.R., Luppino, G.A., & Miyazaki, S. 1995, AAS, 187, 7305

Peterson, C. 1988, PASP, 100, 106

Pierce, M.J., Welch, D.L., McClure, R.D., van den Bergh, S., Racine, R., & Stetson, P.B. 1994, Nature, 371, 385

Spite, F., & Spite, M. 1982, A&A, 115, 357

Trimble, V. 1995, PASP, 107, 977

Tyson, J.A., Wenk, R.A., & Valdes, F. 1990, ApJL, 349, 1

van den Bergh, S. 1980, PASP, 92, 409

Dennis Crabtree works at the National Research Council's Herzberg Institute of Astrophysics in Victoria. He is currently head of the Canadian Gemini Office and Project Manager for the XLT (eXtra Large Telescope) project. For more information see: `gemini.hia.nrc.ca` and `www.hia.nrc.ca/STAFF/cbt/XLT`.

Elizabeth Bryson has been a corporate or academic librarian for thirty-one years; the past twenty-one of which she has been employed as the astronomy librarian for the Canada-France-Hawaii Telescope Corporation in Kamuela, Hawaii. She is a member of and former Chair of the Physics-Astronomy-Math division of the Special Libraries Association.

OPENING OF THE CANADA-FRANCE-HAWAII TELESCOPE

On September 28, 1979, the Canada-France-Hawaii Telescope formally became a reality. It was an occasion all too rare for Canadian astronomers. More than forty-five years had gone by since they had celebrated Canadian acquisition of what was at the time the world's second-largest telescope, and it may be that the twentieth century will pass before they again are involved in building another of the world's great telescopes.

There being no really good sites in Canada or France for optical telescopes, the Canadians and French had brought their hopes and dreams — not to mention detailed plans — to Hawaii. There, with the involvement of that State's university, a site near the summit of the extinct volcano Mauna Kea had been obtained, and there throughout the later 1970's the telescope and its white dome had slowly taken shape. Now, perched almost three miles above the surrounding ocean, it looked loftily down on the clouds and awaited the opening ceremony.

Ambassadors and astronomers, dignitaries and functionaries, some came from half the world away. Proceedings began the previous evening with a magnificient spread of French hors d'œuvres, wines and cheeses at the Kona Beach Hotel. No one made any speeches. No one wore a tie. (Hawaii has many sensible habits.) The hundred or so people merely fell upon the feast and enormously enjoyed themselves. Chatter waxed as the wine waned, bespectacled figures incongruously clad in brilliant Hawaiian shirts gesticulated ever more fiercely over shoptalk.

All too early the following morning heavy touring buses awaited the celebrants. Slowly the buses wound their way up from the sea through changing perspectives of lush pastureland, dry semi-desert, and the pervasive sheets of black rough lava. Ever higher they went, up the saddle road between two of the world's biggest mountains, until at around six thousand feet they stopped. The passengers were decanted into a fleet of waiting four-wheel-drive vehicles and the final assault began. Assault, that is, on the passengers as much as on the summit, for beyond the astronomers' living-quarters at nine thousand feet the road becomes little more than a rough-hewn track winding steeply and precariously through the desolate smashed lava. The vehicles bucked and revved, clawing furiously at the rubble, and the passengers' faces made plain that of hopes and dreams hopes were then clearly dominant.

Eventually all were there, standing on the crushed brown cinders before the white dome, absorbing the dramatic view and what little oxygen was available in the thin air. Many experienced a slight dizziness, and even a few steps along the slopes to snap a picture brought a pounding of the heart, but there were no serious contretemps.

Emerging from the elevator onto the observing floor one was presented with a picture of the telescope such as it surely will never be seen again: garlanded with great arcs of colourful leis it towered over a floor resembling a florist's shop. Officials and onlookers applauded, and the telescope dipped in silent acknowledgement. Those of us used to the clanking monsters of the past era were impressed by the smooth noiseless power of the 300-ton machine and its 450-ton dome. We are also rather glad that no rides in the prime focus cage were proffered.

Indeed, the organizers, doubtless mindful of the many non-acclimatized less-than-fit members in the crowd, did not encourage lingering. Soon we were bundled off down the dusty road with its many spectacular views, back to the buses, and on to the small town of Waimea, where the CFHT headquarters are located. Here in a local hall we were treated to a superb luncheon reception with tropical punch, French wines, and Californian champagne to wash down the excellent local roast beef, a series of toasts which became ever more lighthearted as the meal progressed, and a short address by Dr. Gerhard Herzberg.

Following lunch the crowd adjourned in a certain degree of gaiety to the theatre next door, where Graham Odgers did a splendid job of narrating a film on the building of the CFHT. He, in turn, was succeeded by an equally splendid troupe of Hawaiian musicians and dancers who brought the long day to a delightful close.

I am sure I speak for all who were present when I say that if the Canada-France-Hawaii Telescope Corporation can run their instrument with the same success as they ran its opening, our nations' astronomers have much to look forward to.

by Don Fernie,
from *Journal*, Vol. 74, pp. 101, April, 1980

BROADBAND PHOTOMETRY OF NORTHERN-HEMISPHERE LUMINOUS STARS. VII. *UBV* PHOTOMETRY FOR 38 CASE-HAMBURG STARS[1]

by B. Cameron Reed

Alma College, Michigan
Electronic Mail: reed@alma.edu

(Received August 3, 2001; revised September 24, 2001)

Abstract. CCD-based *UBV* photometry for 38 intrinsically luminous stars drawn from volumes II, III, and IV of the *Luminous Stars in the Northern Milky Way* catalog is reported. Most were imaged three or four times. These objects include a number of bright giants and supergiants of spectral types B, A, and F. All but two are previously unobserved photometrically.

Résumé. Des données photométriques *UBV* recueillies à l'aide de caméra CCD pour 38 étoiles intrinsiquement lumineuses tirées des volumes II, III et IV du catalogue *Luminous Stars in the Northern Milky Way* sont fournies. La plus part de ces étoiles ont été captées trois ou quatres fois chaque. Ces objets comprennent un nombre d'étoiles géantes et super-géantes lumineuses de type spectral B, A et F. Tous, sauf deux, n'avaient pas été observés photométriquement auparavant.

1. Introduction

In a paper published recently in this journal (Reed 2001; hereafter paper VI), this author described a program of photometry and database maintenance for stars listed in the Case-Hamburg luminous stars surveys (Hardorp *et al.* 1959, 1964, 1965; Nassau *et al.* 1963, 1965; Stephenson & Sanduleak 1971; Stock *et al.* 1960; hereafter referred to as the "LS" catalogs). The majority of LS objects are ordinary O–B2 stars and B, A, and F-type giants and supergiants. This paper, the seventh in this series, reports *UBV* photometry for 38 northern-hemisphere LS stars, all but two of which are previously unobserved photometrically.

2. Observations and Reduction

The observations reported here were obtained with the same Lowell Observatory/National Undergraduate Research Observatory (NURO) 31-inch reflector and TEK 512 × 512 liquid-nitrogen cooled CCD chip and *UBV* filter system described in paper VI and references therein. Seven nights covering last-quarter to new moon, July 13/14 through 19/20, 2001, were assigned for this project. All or parts of the last five nights were clear, but calibration of standard-star images obtained during the fourth night (July 16/17) resulted in a large negative extinction coefficient. Data obtained during that night were consequently discarded from all calibrations and reductions. Seeing was typically 1.5 to 2 arcsec. Integration times varied from 3 seconds through the *V* filter for a few very bright program stars (the vast majority of *V*-band exposure times were ≥ 10 sec) to 5 minutes through the *U* filter for the reddest standard and faintest program stars. Since the NURO CCD shutter has opening and closing times of 8 and 10 ms, respectively, any non-uniform illumination of the chip due to shutter motion should be negligible. As in previous observing runs in this series, twenty bias frames were acquired nightly, as were five 1-second sky flats in each filter.

Some 75 observations of standard stars from Landolt (1983) were acquired over the four useable nights of observing; these spanned $V = 8.3$ to 11.7 and $B–V = –0.3$ to 1.6. I carried out synthetic aperture photometry via the "qphot" quick-photometry program within the IRAF software package, utilizing an aperture of radius 18 pixels with sky sampling taken in an annulus of from 18 to 25 pixels radius. Extinction and transformation coefficients were computed according to the multi-night method of Harris *et al.* (1981). Observations of standards were weighted as $(\text{airmass})^{-2}$, and the final weighted RMS residuals in *V*, *B–V*, and *U–B* were 0.0167, 0.0123, and 0.0181 magnitudes, respectively. These figures are each about 0.002 magnitudes higher than those for the October 2000 observing run reported in paper VI, no doubt on account of the more marginal weather characteristic of the summer 'monsoon' season. No non-random trends in residuals as functions of magnitude, colour, time, airmass, or reddening-free parameter Q were evident.

Results for the program stars (in order of increasing LS-North volume number — declination zone — running number) are given in Table I. The columns give (1) LS-North identifier, (2) HD or BD identification, (3)–(5) *V*, *B–V*, and *U–B*, (6) the number of times each star was observed, (7)–(9) the standard deviations of *V*, *B–V*, and *U–B* for stars measured two or more times, (10) the LS-catalog objective-prism spectral classification, and (11) notes. In column (10), "r" designates reddening, "l" that at least one emission line, nearly always a Balmer line, was visible on a blue-region plate, and "h" that Hα was noted in emission on an independently-scanned Hα plate. An "e" in column (11) indicates that a star is flagged in the SIMBAD database as an emission-line star; asterisks direct attention to notes at the foot of the table.

The distribution of standard deviations for program stars measured two or more times is shown in Figure 1, and a colour-colour diagram for all stars appears in Figure 2. The distribution of standard deviations is similar to those found in earlier papers in this series. The solid curve in Figure 2 represents the locus of intrinsic colours

[1] This research was performed at the Lowell Observatory 31-inch telescope, which, under an agreement with Northern Arizona University, is shared with the National Undergraduate Research Observatory.

Table I

UBV Photometry of LS Stars

LS (1)	HD/BD (2)	*V* (3)	*B–V* (4)	*U–B* (5)	n (6)	(*V*) (7)	(*B–V*) (8)	(*U–B*) (9)	Prism (10)	Notes (11)
II +11 2	230579	8.846	0.540	−0.420	4	0.013	0.006	0.012	OB	See text
II +18 6	185605	7.456	0.204	−0.598	4	0.011	0.013	0.017	OB-	
II +19 2	348770	10.577	0.449	0.154	4	0.030	0.022	0.022	F0II	
II +19 6	+19 4003	9.883	1.267	0.759	4	0.017	0.010	0.027	A3II	
II +20 5	+20 4168	10.388	0.828	0.261	3	0.014	0.012	0.025	B8II	
II +21 1		12.959	0.014	−0.657	3	0.029	0.010	0.011	OB	
II +24 1		12.501	0.430	0.022	4	0.031	0.027	0.038	OB-	
II +24 2		11.972	0.640	0.174	4	0.024	0.009	0.010	OB	
II +25 1	338230	10.172	0.561	0.124	4	0.024	0.008	0.024	F4II	
II +27 16	338970	9.985	0.554	0.260	4	0.027	0.016	0.019	A0Ib-II	e
II +28 1	+27 3280	9.711	0.480	0.232	4	0.018	0.022	0.013	F4II	
II +29 3		11.094	−0.024	−0.755	4	0.013	0.018	0.029	OB-	
II +31 9	331319	9.312	0.658	0.434	4	0.044	0.012	0.027	F3Ia	*
II +31 14	331613	9.342	0.731	0.308	4	0.023	0.023	0.014	A0Ibr	
II +33 7	226095	9.174	0.513	0.281	4	0.028	0.013	0.022	F6Ib	
III +46 60	204906	9.974	0.078	−0.589	3	0.001	0.018	0.020	OBl	
III +47 56		10.654	0.014	−0.812	3	0.021	0.017	0.016	OB-	
III +48 47		11.219	0.120	−0.749	3	0.011	0.015	0.010	OB-	
III +48 49		7.554	0.115	0.030	3	0.035	0.018	0.042	OBl	
III +49 47	+49 3932	9.400	0.524	0.236	2	0.028	0.027	0.012	A0Iab	
III +51 39	213050	7.342	0.142	0.066	2	0.004	0.018	0.031	A1Ib	*
III +53 43	+52 3129	9.979	0.168	−0.765	2	0.007	0.007	0.006	OB-	
III +53 48		10.774	0.237	−0.460	3	0.018	0.009	0.018	Obl	e
III +53 71		10.692	0.132	−0.585	3	0.044	0.010	0.010	OB-	
III +54 35		11.027	0.131	−0.665	3	0.006	0.002	0.018	OBl	
III +54 52		10.911	0.239	−0.468	3	0.004	0.002	0.025	OB-	
III +54 82	+54 2931	9.966	0.284	−0.508	1				OB-	
III +55 82	239961	8.755	1.015	0.738	2	0.022	0.021	0.019	F2Ia(h)	e
III +58 7	239646	9.558	0.484	0.142	3	0.025	0.030	0.018	A0Ib	In Tr 37
III +58 10	239731	9.083	0.297	−0.526	3	0.007	0.029	0.022	Obl	*
III +61 6	+60 2322	9.976	0.152	−0.738	1				A0II	
IV −02 25	−03 4475	9.813	0.584	−0.375	4	0.004	0.003	0.012	OB	
IV −01 5		10.760	0.903	−0.098	3	0.008	0.001	0.002	OB	
IV −01 8	−01 3554	9.861	0.601	−0.312	4	0.008	0.012	0.003	OB	e
IV +01 11	182519	7.971	0.063	−0.624	4	0.016	0.012	0.031	OB	*
IV +03 3	+03 3887	9.381	1.024	0.018	4	0.019	0.012	0.007	OB	
IV +04 6		10.327	0.615	−0.238	4	0.009	0.007	0.002	OB	
IV +04 8		10.632	0.684	−0.071	4	0.008	0.010	0.009	OB	

Notes: II +31 9 — IRAS 19475+3119. SIMBAD indicates this object to be a post-AGB star.

III +51 39 — Slettebak & Nassau (1959) classify this star as A0 II.

III +58 10 — ADS 15205AC. In Trumpler 37. Garrison & Kormendy (1976) classify this star as B2 IV. See text.

IV +01 11 — IDS 19198+0138A. Houk and Swift (1999) classify this star as B3 II/III.

for main-sequence stars, and the dashed one that for type Iab supergiants; the solid straight line indicates the reddening line for O5 stars. The distribution of points in the two-colour diagram is consistent with the many less-luminous OB$^-$ classifications appearing in Table I; the points near the supergiant intrinsic-colour locus are all of luminosity class II–III or brighter. As was remarked in paper VI, a minimum reddening of E(*B–V*) ~ 0.2 is present. Maximum reddenings can exceed E(*B–V*) ~ 1, a not surprising result in view of the proximity of these objects to the galactic plane. Given its location at (*B–V, U–B*) = (0.15, −0.74), the LS-catalog objective-prism classification of A0 II for LS III +61 6 is probably in error, although this result is based upon only a single set of images.

Two stars in Table I have measurements in common with results published by other observers. For LS III +58 10, Garrison & Kormendy (1976) reported (*V, B–V, U–B*) = (9.03, 0.30, −0.51) on the basis of two measurements, and noted possible variability. These results agree

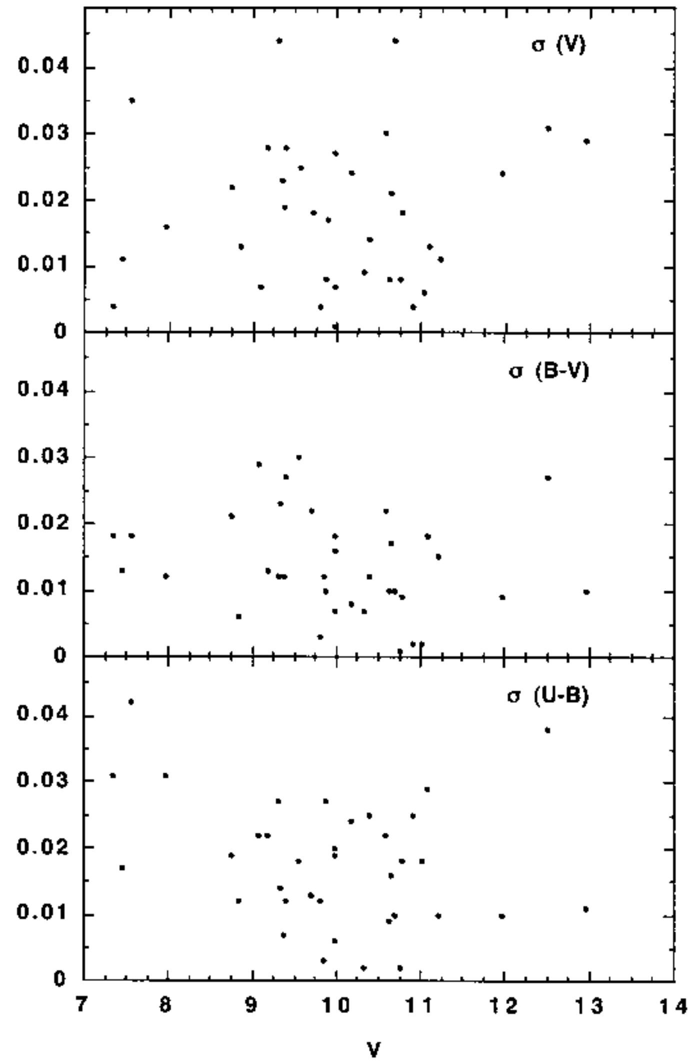


Fig. 1 — Distribution of program-star standard deviations as a function of V magnitude.

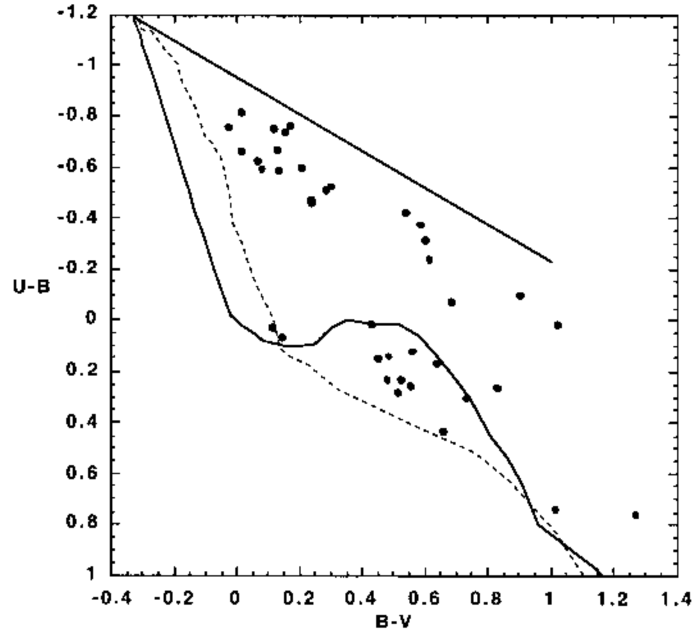


Fig. 2 — Colour-colour diagram for stars listed in Table I. The solid and dashed curves are loci of intrinsic colours for main sequence and type Iab supergiant stars, respectively; the solid line is the reddening line for O5 stars.

well with the present ones; the small standard deviation of the present three V-band measurements, 0.007 magnitudes, argues against variability. LS II +11 2 (duplicated in the LS catalog as IV +11 6) has been measured by three other groups, whose results are summarized in Table II. In my images, this star appeared merged with a fainter companion about 5 arcseconds away; the present results therefore refer to the combined light of both objects. The Moffat & Reed (1999) results (measurements obtained by Moffat) explicitly refer to the primary alone ($V = 9.21$), and give the companion as having $V = 10.44$. When measured together, stars of $V = 9.21$ and 10.44 would appear as a single object of $V \sim 8.91$, in reasonable accord with the present result of 8.85. Hiltner (1956) classified this star as B1.5: IV: ne.

Table II
Comparison of Results with Other Sources for LS II +11 2

Reference	V	$B–V$	$U–B$	n
Present work	8.846	0.540	−0.420	4
Kozok (1985)	9.300	0.575	−0.354	2
Hiltner (1956)	9.13	0.53	−0.41	2
Moffat & Reed (1999)	9.21	0.49	−0.43	1

Finally, it is worth emphasizing as in paper VI that some 5000 LS stars still lack basic broadband photometry. These objects represent attractive targets for amateur astronomers with modest-aperture telescopes equipped with modern imaging systems. A listing of epoch-2000 coordinates for unobserved LS objects can be found at the author's anonymous ftp site given in paper VI.

Acknowledgments

It is a pleasure to thank Ed Anderson of Northern Arizona University/NURO for his usual excellent support at the telescope. This research made use of the SIMBAD database, operated at CDS, Strasbourg, France, and was supported by the National Science Foundation via RUI grant AST-9731179.

B. Cameron Reed
Department of Physics
Alma College
Alma, MI 48801
U.S.A.

References

Garrison, R.F., & Kormendy, J. 1976, PASP, 88, 865

Hardorp, J., Rohlfs, K., Slettebak, A., & Stock, J. 1959, Luminous Stars in the Northern Milky Way I. (Hamburger Sternwarte and Warner and Swasey Obs.: Hamburg-Bergedorf)

Hardorp, J., Theile, I., & Voigt, H.H. 1964, Luminous Stars in the Northern Milky Way III. (Hamburger Sternwarte and Warner and Swasey Obs.: Hamburg-Bergedorf)

Hardorp, J., Theile, I., & Voigt, H.H. 1965, Luminous Stars in the Northern Milky Way V. (Hamburger Sternwarte and Warner and Swasey Obs.: Hamburg-Bergedorf)

Harris, W.E., FitzGerald, M.P., & Reed, B.C. 1981, PASP, 93, 507
Hiltner, W.A. 1956, ApJS, 2, 389
Houk, N., & Swift, C. 1999, Michigan Catalogue of Two-Dimensional Spectral Types for the HD Stars, (University of Michigan: Ann Arbor)
Kozok, J.R. 1985, AAS, 61, 387
Landolt, A.U. 1983, AJ, 88, 439
Moffat, A.F.J., & Reed, B.C. 1999, PASP, 111, 1149
Nassau, J.J., & Stephenson, C.B. 1963, Luminous Stars in the Northern Milky Way IV, (Hamburger Sternwarte and Warner and Swasey Obs.: Hamburg-Bergedorf)
Nassau, J.J., Stephenson, C.B., & MacConnell, D.J. 1965, Luminous Stars in the Northern Milky Way VI, (Hamburger Sternwarte and Warner and Swasey Obs.: Hamburg-Bergedorf)
Reed, B.C. 2001, JRASC, 95, 64 (Paper VI)
Slettebak, A., & Nassau, J.J. 1959, ApJ, 129, 88
Stephenson, C.B., & Sanduleak, N. 1971, Luminous Stars in the Southern Milky Way. Publ. Warner & Swasey Obs., 1, 1
Stock, J., Nassau, J.J., & Stephenson, C.B. 1960, Luminous Stars in the Northern Milky Way II, (Hamburger Sternwarte and Warner and Swasey Obs.: Hamburg-Bergedorf)

B. CAMERON REED is currently a professor in the Department of Physics at Alma College, Alma, Michigan, where he teaches physics and astronomy. He earned his B.Sc. (1977) and Ph.D. (1984) from the University of Waterloo and his M.Sc. (1979) from Queen's University. His professional interests lie primarily in the study of galactic structure and in OB stars in particular. He lives in Alma with wife, Laurie, and cats, Fred & Leo.

Society News/Nouvelles de la société

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

This year has just passed us by like the speed of light. As I write this, its already late fall coming into Christmas, and I would like to take this opportunity on behalf of the RASC to wish all our members a Merry Christmas and safe New Year. Let's hope that clear skies will be forecast over the holiday season, and the presents of eyepieces, scopes and CCD cameras can be used.

National Council Updates

On October 27, 2001, a National Council meeting was held in Toronto. At the time this article was submitted, a report on the meeting was unavailable, but it will appear in the February issue.

National Office Updates

Bonnie and Isaac have been working hard on membership renewals and co-ordinating sending the 2002 Handbooks to paid-up members. Look in the mail to find your copy of the *Observer's Handbook* shortly. If you have any questions about memberships or renewals, please speak to your Centre representatives, give Bonnie and Isaac a call, or send an email (`member@rasc.ca`) to the National Office.

Congratulations

A Letter of Congratulations was sent to Regina member, Vance A. Petriew on his discovery, Comet Petriew C/2001 Q2, a periodic comet, announced in *IAU Circular 7686*, and discovered on August 19, 2001 at the Saskatchewan Summer Star Party.

Congratulations to Doug George on his 8th supernova, along with Tim Puckett, of the Puckett Observatory. The announcement was made in *IAU Circular 7690*. This is the 36th discovery of a supernova at the Puckett Observatory.

Recent Events Across the RASC

In a recent RASC event, the RASC-Moncton Centre held their 1st Annual Conference on November 10, 2001 at the Université de Moncton. The event started at 9:00 a.m. and lasted until 5:30 p.m. Please visit their Web site for more details, `www.rasc.ca/moncton`. We are looking forward to a report from Moncton on this event.

Analemma in the Sky

by Steve Irvine (steve@steveirvine.com)

What is an analemma? A typical definition would be: a scale shaped like the figure 8, showing the declination of the Sun and the equation of time for each day of the year. That may not help much, so think of it another way. If every few days, at exactly the same standard time of day, an observation were made of the Sun's position, it would be noticed that the Sun's location changes slightly both up and down, and also from side to side. Over the course of one year, the changes in the Sun's position describe an elongated figure 8 stretching across about 47 degrees of the sky. It is this pattern that makes the analemma, and this is what I captured on film with Keppel Henge in the foreground.

The photograph shows the analemma pattern made by the Sun during one year. The camera was facing towards the southeast. At my latitude and longitude, the Sun reaches its highest elevation on June 12th. It is farthest north on June 26th and crosses the figure-8 pattern on August 30th. The Sun follows the pattern down and reaches its farthest point south on December 5th. It reaches its lowest elevation above the horizon on December 29th. The Sun then begins gaining elevation again and once again crosses the figure-8 pattern on April 12th. The Sun turns the corners of the analemma on the days of the summer and winter solstice. Keppel Henge is located at roughly 44° 47′ N Latitude and 80° 56′ W Longitude, near Georgian Bay, Ontario (see `www.steveirvine.com/henge.html`).

At present, only a few analemma photographs are known to exist. The reason is that there are some daunting technical challenges, starting with positioning the camera properly to take in the entire figure during the course of the year. Collecting multiple exposures throughout the year creates the figure-8 image. I photographed the Sun at 8:30 a.m. Eastern Standard Time every ten days, on average, from May 2000 to May 2001. This resulted in 35 multiple exposures on one frame of film that all lined up to form the finished image. An additional unfiltered image was made of the landscape without the Sun in the frame to give context to the photo, for a total of 36 exposures. As an added challenge, the camera was located out in a field; most other analemma photos have been taken through a window.

A number 12 welder's shade was held over the lens for the Sun exposures. The camera is a Canon A-1 and is designed for taking multiple exposures. It was fitted with a 28-mm lens set to f/2.8. The shutter speed was 1/250 second. I used Kodak Gold Select 100 print film. The camera was positioned and locked in place on a wooden mount, which in turn was bolted in place for the exposures and then removed for storage between exposures. Our seasonal weather here in Canada is much too extreme to leave the camera in place throughout the year. A special wooden box was made to carry the camera and mount out to the henge site for the exposures, and for storage. The camera mount was bolted to a 4-by-4-inch wooden post and the post was set in concrete.

It was an interesting process working on this project during the year. It required equal doses of planning, luck, persistence and optimism. There were some real challenges with the weather. The winter months were the most difficult stretch. Winters at the Keppel Henge site can be very snowy and quite cold. We had a total snow accumulation during the winter of 16 feet, and that made it a little difficult to get out to the henge site. I had to give myself a bit more time to get set up for each exposure. This winter was cloudy as well. Keppel Henge is surrounded by the Great Lakes and lake-effect clouds are common during the winter months. We can go weeks on end with hardly a sunny day, and that was the case from mid-January until the end of February. However, the winter also held some of the best moments too, such as finding fresh coyote and deer tracks in the snow by the henge. One very bright but cold winter morning I noticed a pair of delicate, rainbow-hued sundogs on either side of the Sun rising gracefully with it above the horizon. I also remember how happy I was to see the Sun image well within the camera frame as it rounded the ends of the figure. It meant that the planning done many months earlier had been correct and that I wouldn't have to start over again!

Why not try your own analemma photo? Each one is totally unique, and so is the experience of attempting one!

Steve Irvine lives on the Bruce Peninsula where he enjoys the dark night skies. Another recent project at Keppel Henge was the construction of a six metre wide analemmatic sundial.

Blinded by the Light

by Angela Squires (esquire@vcn.bc.ca)

"Lack of awareness, rather than resistance, is the biggest problem in controlling light pollution," writes David Crawford in the *Observer's Handbook*. Whenever the subject of my hobby of astronomy comes up, people are always interested, even the ones who at first are thinking of astrology! I mention my forays to the dark skies of Manning Park, B.C. and Oregon, and we're into light pollution. Once I've briefly explained what light pollution is, faces light up and people tell me their pet peeves. Whether it's a neighbour's so-called security light, a big-box store's parking lot lights, streetlights or vehicle headlights, the people I've talked to are all bothered by excessive glaring light from poorly designed lamps.

"Lack of awareness, rather than resistance, is the biggest problem in controlling light pollution," writes David Crawford in the Observer's Handbook.

Like myself, the media found a receptive audience and responded accordingly. July 1999 saw wide news coverage of the formation of the Torrence Barrens Dark Sky Preserve in Ontario, followed by "Let There Be Dark" in the May 22, 2000 issue of *Maclean's* magazine. The controversy over Famous Players' Colossus searchlights in Langley attracted media attention here and across Canada. A strongly worded press release successfully directed their interest, resulting in newspaper, magazine, television, and radio coverage of this issue and light pollution in general. The *Vancouver Sun, Province, Globe and Mail,* and *National Post*, along with local papers, covered the Colossus story. *Western Living* magazine's October 2000 lead article featured "Darkness Visible" by Jennifer Williams with a superb composite photo of a starry night and sunset city skyline. I was delighted with this succinct, excellently written and edited article. "Bring on the Night" by Judy Ross appeared November 2000 in Air Canada's in-flight magazine, *En Route*, and featured eleven pages of information mostly from the International Dark-Sky Association (IDA) and photos from space showing the lights of each continent. It also included the Colossus story and quotes from our member and Langley, B.C. resident, Mike Pendleton: "People like to look up and enjoy the sky without lights crisscrossing it. . . . Besides, no one has the right to use the night sky as a commodity." In December 2000, *Vancouver Magazine* published an article by Alisa Smith followed by the *Westender* newspaper with a cover story by Tom Zillich, "The Fight against Light."

The true Millennium dawned, and I decided to go public. Previously, for strategic reasons, I had provided information, but referred writers to others for quotes and their name in print. Alison Applebe and I had talked about her writing an article while she was still a staff reporter at the *Vancouver Courier*. By the time we got around to it, Alison had fled the horrendous biweekly deadlines for a freelance career and was able to write a comprehensive, locally focused cover story that was published by the *Courier* on Sunday, March 18, 2001. A distinctive Randall Cosco cover photo and the Earthlights from space image by NASA complemented Alison's excellent article. It was a serendipitous coincidence that Paul Greenhalgh and I were interviewed about light pollution and the MacDonald Dark-Sky Park in Abbotsford, B.C., on the *Vicki Gabereau Show*, which aired the following Thursday. This double exposure surely led to my interview on the *Rafe Mair Show* for CKNW Radio, Monday, April 9, 2001. Rafe is personally concerned because he almost killed himself in a serious accident at 6 a.m. one day. He became disoriented by oncoming headlights and drove off the Squamish Highway on his way to work from Lion's Bay. Rafe is interested in a follow-up interview specifically about vehicle light, so I am in the process of pestering manufacturers and transport authorities.

Light bucket — a whimsical, ready-made light shield in Winthrop, WA, photograph by Bruce Weertman of Dark Skies Northwest. Is the owner an astronomer per chance or was a bucket the first thing in hand in this rural community south of the Okanagan?

Scott Griswold's photo of a full cutoff (FCO) light fixture and a drop lens 'glare bomb' gives a good comparison of their different effects but is not the same as the human eye perceives.

Where do we go from here? Given the public concern and interest in health matters, I think the light, melatonin and cancer connection merits a comprehensive press release. This is a contentious issue because of the pharmaceutical and medical industry's huge financial stake in treatment protocols. Money is not made but saved by prevention. Dr. Stephen Pauley of Ketchum, Idaho, is the Dark Sky List member who has informed us of much of the research about the effect of light on our bodies. Steve's "signature" to his postings can only be ignored at our peril: "Nature bats last and owns the stadium."

Allowing for our increased ability to detect the specific causes of ill health and mortality, there is no doubt that certain diseases, for example cancer, are more prevalent today than say fifty years ago, especially amongst residents of the industrialized nations. Why is this so? For me the answer has to lie in the dramatic changes we have wrought upon our natural environment. While more obviously noxious pollutants come to mind at first, I believe we have underestimated the detrimental effects of artificial light. For hundreds of thousands of years, life evolved in concert with nature's circadian rhythm, the cycle of day and night dictated by the Earth-Sun geometry. The urban blight of artificial light has been with us but a moment on this time scale and has increased exponentially over the past 30 years. The laws of causality rule, whether by a process inherent to the natural world or the tool of a higher power. We exist today by the grace of mostly natural, not manmade conditions.

At the IDA annual meeting held March 9–11, 2001 in Tucson, three of the top researchers in the field of physiological and pathological effects of exposure to light at night on humans participated in a panel moderated by Steve Pauley. Steve's report, "The Dark Side of Light," accompanies this issue.

Angela Squires strongly believes that public awareness of light pollution issues will result in widespread demand for responsible lighting standards. Her eclectic approach draws on experience in the fields of education, art, photography, lighting sales, marketing, and media relations. She serves as public relations director for the Vancouver Centre and chairs CERL, their Council for Education in Responsible Lighting.

OCTOBER 2001 JOURNALS WANTED

Due to unexpected increases in membership, the society is short copies of the October 2001 issue of the *Journal*. If you no longer need your copy, please send it to the RASC National Office at 136 Dupont Street, Toronto, ON M5R 1V2 (or contact Bonnie Bird at rasc@rasc.ca, or phone: 1-888-924-7272 (in Canada) or 1-416-924-7973).

THE DARK SIDE OF LIGHT

by Stephen Pauley (spauley@cox-internet.com)

Summary of the Panel on the Physiological Effects of Exposure to Light at Night on Humans held at the International Dark-Sky Association (IDA) Annual Meeting, March 9–11, 2001. Participants were Stephen Pauley MD, Otolaryngologist (retired); Russ Reiter PhD, University of Texas Health Science Center; David Blask MD, PhD, Laboratory of Experimental Neuroendocrinology/Oncology, Bassett Research Institute; George Brainard PhD, Department of Neurology, Jefferson Medical College.

Stephen Pauley stressed that over the past 120 years — since Edison's light bulb — we humans have made a big disconnection from nature's age-old protections that the human body has incorporated for rest and repair during sleep and darkness.

Stephen Pauley

Stephen Pauley reviewed the anatomy of the biological clock in the hypothalamus and the location of the pineal gland. He reviewed the complex nerve pathways from the eye to the biological clock in the hypothalamus, to the brainstem, to the spinal cord, to a ganglion in the neck, and back up to the pineal gland in the centre of the brain. There the nerves meet cells (pinealocytes) in the pineal gland. At that junction, norepinephrine is either secreted or inhibited by light and/or dark, and that in turn regulates the pineal's natural production of the hormone melatonin.

Stephen Pauley stressed that over the past 120 years — since Edison's light bulb — we humans have made a big disconnection from nature's age-old protections that the human body has incorporated for rest and repair during sleep and darkness. For aeons, and before the electric light, we relied on darkness to produce melatonin from the pineal gland. Melatonin has antioxidant properties that could slow the aging process. It induces sleep, boosts the immune system, and regulates the production of other hormones like estrogen and prolactin. Our normal homeostasis (balanced body physiology) depends on our knowledge of, and our paying attention to, the Earth's day-night cycles. Day-night cycles set the rhythms of our master clock — the paired suprachiasmatic nucleus (SCN) in the hypothalamus. Clock-melatonin rhythms have existed in all living things since life began on Earth.

We know that tampering with or changing these body processes, as we do in our stressful, hectic, modern-day world where we may work at night and get little sleep, makes us more prone to illnesses such as diabetes, cancer, and heart disease. Wishing for eight hours of sleep in darkness is considered a weakness, not a virtue that ought to be worked on.

Exposure to light at night suppresses human melatonin production from the pineal gland that should naturally produce melatonin at night in darkness. Melatonin-regulated hormone secretions from the hypothalamus then regulate the secretions of pituitary hormones that control our endocrine glands: the thyroid, pancreas, ovaries, testes, and adrenals.

Pauley suggested that because of light's ability to inhibit melatonin from the pineal gland, light at night should be considered a drug. Therefore, light manufacturers should be obligated to minimize human exposure to poor night lighting, *i.e.*, lighting that produces glare and light trespass. He said research by biological-clock and pineal physiologists is moving very rapidly, and even specific clock genes are now known. But this knowledge is shared only among a small group of scientists. Pauley suggested that the IDA should become a bridge to bring the lighting and medical communities together to share ideas and knowledge. He said it was time for the lighting industry to take note of the harmful effects of exposure to light at night on humans, and for the industry to make more and better full cut-off fixtures.

Russ Reiter

Russ Reiter, the dean of melatonin research, has trained over 130 doctoral students in circadian and pineal physiology. He has authored or co-authored over 700 papers in his field and has received several honours. He is also the author of the book *Melatonin* published by Bantam Books in 1995. The book is an excellent layman's guide that explains the beneficial properties of melatonin and why we need it.

Reiter refered to melatonin as "the hormonal expression of darkness." In his presentation, he said melatonin is present even in algae and has existed in both plants and animals for over 3 billion years. Light-dark cycles influenced by clock genes cause melatonin levels to rise at night in darkness and fall during daylight. This melatonin rhythm is seen in all organisms so far studied — even in nocturnal animals. It is a basic protective process that has evolved from the beginning of time. His experiments on humans and animals consistently show inhibition of nighttime melatonin secretions caused by exposure to light at levels as low as 10-foot candles.

Reiter discussed the anti-oxidant effects of melatonin — how the hormone gets rid of free radicals produced by mitochondria within the cytoplasm of cells during cell respiration. He explained that 2–4% of the oxygen used in energy cycles within the mitochondria escapes in the form of damaging free radicals, which also may initiate cancer growths. We depend on the natural nighttime pineal melatonin production to clear these free radicals from our blood. Exposure to light at night interferes with that process by stopping melatonin production.

Melatonin is by far the most potent of the anti-oxidants, much more so than vitamins C, E, and A. The reason is that melatonin is soluble in both fat and water, and can therefore enter some cells that vitamins cannot. For example, vitamin E is soluble in the lipid part of the cell only, and vitamin C only in the aqueous part. Melatonin is soluble in both.

Melatonin has many beneficial effects. Dr Reiter mentioned that melatonin neutralizes a free radical found in Alzheimer's patients. Melatonin also boosts the immune system, lowers cholesterol, protects the body's cardiovascular system, helps counter the side effects of radiation and chemotherapy, stabilizes the body's biological rhythms, and restores the nightly cycle of rest and repair.

We need daily exposure to natural sunlight to reset our biological clocks that tend, if left in the dark, to run our body rhythms on a 24.3-hour cycle. (Our biological clocks run just a little slow compared to the normal 24-hour day-night cycle.) Similarly, we need to sleep in total darkness to allow the pineal to produce melatonin. Reiter stressed this is especially true for our children's well being. Many sleep disorders can be corrected by paying attention to these simple suggestions. As we age, melatonin levels become lower. By taking 0.5 to 5 mg of melatonin at night, we can help improve our health as we sleep. For the elderly the optimal dose may be as low as 0.2 mg. There are virtually no side effects from taking melatonin.

David Blask

David Blask's work centres around the effects of light exposure and melatonin levels on the growth of human breast cancer cells implanted in rats.

He began with an overview of the beneficial effects of melatonin calling the hormone an aid in regulating our "homeokineses" rather than our "homeostasis" as Steve Pauley had said. Homeokineses implies that melatonin regulates the ongoing rhythms of the body rather than regulating a static situation, as implied by the word homeostasis. Blask made the analogy of the biological clock in the suprachiasmatic nucleus of the hypothalamus as the drum which synchronizes our body rhythms for optimal performance.

Blask pointed out that there are now five studies showing that completely blind women with no light perception have an incidence of breast cancer 40% lower than the mean. He suggested that maybe the blind women's overall lower rates of cancer are the norm — as humans used to be before electric lights and fatty diets — and it is those of us in modern times who are abnormal. In the industrialized world, we are exposed to light at night and eat fatty foods, and we are the ones with the overall higher rates of cancer.

Blask mentioned a newly published study from Denmark showing that shift workers have a 50% to 70% higher rate of breast cancer. The longer the time spent as a shift worker, the higher the rate of breast cancer ("Increased Breast Cancer Risk among Women Who Work Predominately at Night," Johnni Hansen, *Epidemiology*, vol. 12). He stressed that breast cancer in humans is a growing, uncontrolled problem especially in the industrialized world where people are exposed to far more light at night and where people eat diets rich in polyunsaturated fats.

Blask reviewed his research on rats and breast cancer growth. He surgically implanted a known strain of human breast cancer cells (known as MCF-7) into the groin of rats. After a few days, rat blood vessels grow into the cancer cells and provide a nourishing medium for cancer cell growth, from which blood samples may be taken. Even though rats are nocturnal, they still have a nocturnal spike of melatonin when in darkness — a universal trait of all organisms as mentioned above.

Dr. Blask found that the human breast cancer cells grew rapidly when the rats were exposed to light at night at luminosities as low as 0.02-foot candle — the light was placed 1 m away from the cages. An expected drop in melatonin levels was also seen. Rats kept in darkness had far less growth of the breast cancer cells and a higher level of melatonin, as expected. He also found a correlation between tumor uptake and metabolism of an omega-6 fatty acid called linoleic acid (LA) and increased cancer cell growth. The growing cancer cells in the light-exposed rats were found to take up higher levels of LA as measured by an increased level of a metabolite of LA called 13 HODE. This relationship is reversed in darkness. These responses were greatest with a breast cancer cell type called "estrogen receptor positive."

Summary of Dr Blask's Research

"Light of appropriate intensity, duration, timing and wavelength, present during darkness, stimulates human breast cancer progression via melatonin suppression and results in disinhibition of tumor linoleic acid uptake and metabolism."

The results need follow up to determine if "… findings suggesting that light during darkness is a potentially serious health risk for breast cancer progression may perhaps lead to preventative measures for lowering the incidence of breast cancer by combining modifications of indoor (and outdoor/sp) artificial lighting and shift-work schedules with alterations in dietary fat intake and melatonin supplementation." Both light at night and fatty diets exist more in the industrialized world, and that may be why those societies have higher rates of breast cancer.

George Brainard

Dr Brainard could speak only on the following day because of time conflicts. His early work was with Syrian hamsters, a seasonally reproductive mammal. He found that the gonads of male hamsters increased and decreased in size depending on the breeding season or time of year. He could change the size of the hamsters' gonads and melatonin production by changing their exposures to light and dark cycles. This work shows the importance of light-dark cycles, circadian rhythms, and melatonin output levels in the regulation of a seasonally breeding mammal.

Brainard's recent work was on humans — over 600 healthy young volunteers. The purpose was to determine which specific wavelength of light was most potent in lowering melatonin levels in humans.

The studies took place at 2 a.m. when volunteers' melatonin levels were at their peak. Their pupils were dilated with drops and their chins placed on an eye exam head holder. They were told to stare into a dome, which produced different wavelengths of monochromatic (one colour only) light. Cameras recorded whether the eyes were fully opened and pupils dilated. Blood samples for melatonin were drawn at the beginning and end of the ninety-minute exposure.

The results revealed that short wavelength light in the blue portion of the visible spectrum was most potent for lowering melatonin. The results suggest that the regulation of pineal melatonin production in humans is not mediated by the classical visual rod and cone photoreceptor. Instead, the results indicate that the retina of the human eye has a novel photoreceptor that is primarily responsible for regulating production of melatonin from the pineal gland. Luminance levels as low as 0.5 to 1.7 foot-candles of blue-green light at 509 nm, and 10 foot-candles of broadband white light, can lower melatonin levels under tightly controlled exposure conditions.

At the general membership meeting, David Crawford appointed Steve Pauley as chairman of the IDA's Photobiology-Pathology working group. A web page will be established on the IDA website with references to research articles related to light and its effects on plants and animals.

Stephen Pauley is a retired Otolaryngologist (head and neck surgeon) who currently lives in Sun Valley, Idaho. Among his many activities, he occasionally writes an astronomy column "Skywatch" for the Wood River Journal.

ANOTHER SIDE OF RELATIVITY

Callisto's Calypso (Coda)

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

"Regretfully, I guess I have three simple things to say,
Why me? Why this, now? Why this way?
With overtones ringing and undertows pulling away
Under a sky that is grey, on sand that is grey, by an ocean that's grey"
— Ani diFranco, "Grey"

Observing Log 2001/09/27: I better start writing this now, at 3 a.m., while observations of the Callisto event are still fresh in my mind. I depend so totally on my memory that I didn't even think to take a hand-held tape recorder with me. If you want to imagine walking the tightrope without a net, imagine relying utterly on a memory which can't remember the @#$%* tape recorder. Such is the precarious state of my existence.

After a week of continuously clear skies and fabulous weather, the clouds rolled in and out throughout the day, just in time to throw tonight's predicted partial eclipse of Callisto under a shadow of doubt. The evening was spent riding an emotional elevator, free falling from hope to despair with each new cloud bank as I tried to envision the state of the sky at 1 a.m. MDT, the time of maximum eclipse.

My "flutter-bys" were the familiar ones that precede any significant "real-time" astronomical event, such as an eclipse, a grazing lunar occultation, an asteroid occultation, or a comet crash. In this case, my anxiety was two-fold: not only did I want a rare second chance to see such an interesting event, but I had something of a personal stake in it, having predicted the partial nature of the eclipse in this space two issues ago. Publicly contradicting the *Observer's Handbook*, especially in an esteemed scientific journal such as this one, was a new and giddy experience. I wanted to see with my own eye that I had got it right. (McCurdy 2001)

By midnight the vast majority of the cloud had retreated to the eastern horizon, which unfortunately was where Jupiter was rising. With my poor local horizons, I had to drag my 8-inch f/8 Newtonian and tripod-mounted 10×50 Celestron Ultima binoculars to the school field a half block north of my home near downtown Edmonton. Unburdened as I was by tape recorder, I borrowed my son's portable CD player with its aptly named BrainShaker™ headphones — my own brain positively rattled — for a detailed listen to the great new double CD by Ani diFranco. There's nothing like music to calm the nerves.

To my dismay, the clouds got to about 10-degrees altitude and simply stopped moving. Just 12 degrees to Jupiter's north, Castor popped in and out of view, sometimes for minutes on end. Meanwhile, another set of clouds came up from the southwest, covered the Moon, and quickly set about invading the eastern sky as well. My heart sank as I pondered the distinct possibility of a complete shutout. I checked my watch frequently as it crept past 12:37, the beginning of the eclipse predicted in the *Observer's Handbook*. By now the partial eclipse, which a poetically inclined friend of mine dubbed a Callipse, had to be well underway. Or so I hoped.

At 12:46, the unmistakable creamy beacon of Jupiter suddenly and reassuringly cut through the crud. Within seconds I had spotted the distant satellite lovingly referred to as "IV," relatively faint but still quite easy to see. I was quickly convinced that not only had it not disappeared, it wasn't about to anytime soon (although I could see no sign of it in the binoculars, normally a dead cinch). For five precious minutes I watched it slowly fade relative to the other moons and the one nearby comparison star. At magnitude 6.9, the star appeared brighter than Callisto throughout; in fact to my eye it also appeared brighter than Io and Europa, which were bathed in the glare of Jupiter.

I concluded it is in fact very difficult to compare a star with a moon, almost a case of "comparing apples and oranges." The star looks smaller, scintillates more, and appears to have a higher "surface brightness," while the moon is clearly a tiny disc, which to my eye reflects a slightly flatter light. (I've noticed this effect before on occasion when visually picking Pluto or an asteroid out of a star field.) And the out-of-focus method doesn't work because bloated Jupiter appears to eat its young.

I didn't even get a chance to compare Callisto with the fainter stars on my printout because, as I changed to a low power eyepiece, Jupiter disappeared into the upper cloudbank descending from the west. I got another peek a minute or so later with Callisto still easy, then the clouds again ruled the sky. At 12:59, virtually at mid-eclipse, Jupiter flared briefly again; it took me a second to reacquire it in my non-driven scope, and I glimpsed Callisto for literally a split second before the next cloudbank cruelly swallowed it first, quickly followed by Io and then Jupiter itself.

For the next 20 minutes the clouds moved so incredibly slowly I felt like I was following a fully-loaded logging truck up a switchback mountain road. Impatience and observing are rarely compatible, but then again, I wasn't observing, was I?

Pollux, a degree lower than Jupiter and only a short distance to its north, came out and stayed out, taunting me. As I waited, Ani diFranco's words cited above came through the headphones, forcing me to laugh aloud. No sand, no sea, and only a small portion of the sky was grey, but indeed I asked "Why me? Why *this*, now?"

With nothing to do at the eyepiece, my mind returned to a question I had pondered earlier in the day about the rarity of tonight's event. How rare? There are two eclipse series of Callisto for each Jovian orbit, and the partial eclipses all occur right at the beginning or end of a series. So there are four windows per dozen years, with perhaps two observable events in each window, essentially one deep fade and one shallow fade.

But how often are they truly observable? Using the simple criteria that Jupiter must be in the observer's sky and the Sun not, that already reduces the possibility of seeing any given event down to 0.5×0.5 = 25%. For the problem at hand, the Sun must realistically be at least at civil twilight, defined as 6 degrees below the horizon, for the sky to be dark enough to pick up subtle changes in light on the moons. The back of my mental envelope suggested that, particularly at a high latitude like Edmonton's, this would reduce the "dark sky" observing window to more like 40%. (My friend Russ Sampson took a more formal mathematical approach to come up with a figure around 42%.) Also, for any real chance to observe an event, Jupiter must be at least, say, 6 degrees *above* the horizon. Presumably one could plug in the same figures as for civil twilight. So now you're dealing with something closer to 0.4×0.4 = 16%. By the time you include the weather factor, the chances of seeing any given event from a given location are probably not much greater than 10%. So for me to see two consecutive deep Callipses was to beat hundred-to-one odds.

Finally at 1:19 Jupiter was back, more or less to stay. Callisto was immediately apparent, a little brighter than my first view at 12:46, which figures since we were now further removed from the midpoint. Although under the circumstances I was reluctant to guess in less than whole magnitudes, I estimated mag 9 then, closer to 8 now. While IV continued to brighten, it was not significantly different than any other Galilean satellite eclipse reappearance, remarkable to this experienced observer of such events only by the extremely slow pace of the change in illumination. At 1:40 I remembered to look through my binoculars, and Callisto had indeed returned. By 2:00 all had returned to normal as Jupiter shone steadily through an annoyingly large stable patch of clear sky.

So, in the end, my observations were considerably less than fully satisfying. The slow pace of these events normally allows me time to conduct thought experiments, such as the one that led me to predict this event in the first place. Came the night, however, and I felt rushed and frustrated. In the end, I was able to observe for only a dozen or so of the 47 minutes of "eclipse disappearance" forecast by the *Handbook*.

On the other hand, the mere glimpse of Callisto at mid-eclipse confirmed my basic premise. This positive feedback from my skies verified that this time at least, I was on the right track. I felt like an ancient eclipse predictor, drawing on the natural rhythms of the sky and a little mental geometry to turn some subtle clues into an accurate forecast. To actually see this tiny, distant moon fade but not go out was very cool; but the fact it was my own independent prediction that compelled me to look was a victory of logic. Observation had inspired theory, which was confirmed by further observation. I felt as if Callisto's slow, subtle wink was intended just for me.

And to think just like those ancient eclipse predictors, I had little more at my disposal than my wits, my *Observer's Handbook*, Jean Meeus' *Astronomical Tables, Guide 7.0*, and an 8-inch telescope!

Unfortunately, it turned out IV's wink very nearly was a private affair. Despite my best efforts to publicize this event nationally, I subsequently heard back from only two RASC members who attempted to observe the phenomenon; Geoff Gaherty was clouded out in Ontario, and (as also predicted in my previous column) rain in Newfoundland washed out Gary Dymond's efforts. It made me wonder, sadly, how many potential observers had not yet removed the shrink-wrap from their *JRASC*, the opportunity now irretrievably lost. In the end, I heard a single positive report, from Geoff's friend Vic Palmieri in New Jersey, which at least provided independent confirmation of my observation, and more importantly, the prediction.

I guess it could have been worse. At least I didn't get a hundred e-mails saying "Hey, idiot! I got up in the middle of the night and saw absolutely nothing!"

Oh, well, there's always next time. Or is there? As pointed out above, the odds are against us. The end of the now-underway eclipse series, in September 2004, and the beginning of the next one, in January 2008, both occur while Jupiter is in conjunction with the Sun. The next viewing opportunity is in September 2010, when the better of the observable events occurs within a couple of days of opposition. Sounds ideal, right? Not so fast. Earth will be on virtually the same line of sight as the light source, so an observer would hardly be able to discern Jupiter's shadow. Callisto will likely be lost in Jupiter's glare, almost visually occulted by its limb. And to see even that much, you'd better be planning a trip to Europe because it occurs at the wrong time of day.

With each 11.86-year Jovian orbit, subsequent events within my lifetime occur ever earlier in the calendar year. Indeed, three of the four orbital windows seem to share an interesting ~3.0 year resonance. This group is soon to cluster in the summer months, meaning that from 2013 to 2034 six of eight windows will occur within a few weeks of the June solstice, when the odds are further stacked against a favourable observing opportunity from the northern hemisphere. So I think my personal life log is doomed to remain at two Callipses. On the bright side, that may be some sort of Canadian record or something. (Meeus 1995)

Back at the eyepiece, with Callisto back to normal at 2 a.m., I swung my scope up to Saturn for a quick peek before packing up, but it immediately disappeared into a cloud about an eighth of a degree high. It definitely wasn't my night. I closed up shop, Ani diFranco's words in my ears drowning out my own rather less poetic ones. Grrr.

In the movie *Bull Durham*, the minor-league catcher and major-league philosopher Crash Davis utters these immortal words of wisdom: "Sometimes you win, sometimes you lose, sometimes it rains." Call this one a draw: McCurdy 1, Murphy 1. A handshake with a worthy opponent is an honourable result, and it certainly beats not showing up for the game.

References

McCurdy, Bruce, August 2001, JRASC, 159

Meeus, Jean 1995, Astronomical Tables of the Sun, Moon, & Planets, (2nd ed.; Willmann-Bell Inc.), 25, 30, 58

Acknowledgements

The assistance of Geoff Gaherty, Sherrilyn Jahrig, and Russ Sampson is gratefully acknowledged.

Bruce McCurdy is a Past President of the Edmonton Centre and an active astronomy educator. He delights in observing astronomical phenomena that exhibit four-dimensional dynamics and is therefore an avid watcher of Jupiter and its satellites.

Scenic Vistas

Lepus 'n' Lynx

by Mark Bratton (mbratton@generation.net)

The many brilliant constellations of the winter sky, Orion, Taurus, Auriga and Gemini to name four, tend to draw the attention of the observer with a small telescope since they also contain a plethora of brilliant clusters and nebulae, some of them the most famous in the heavens. The fainter, less well-placed constellations tend to get ignored under these circumstances, although they too are home to objects of interest to the determined observer.

Immediately below Orion, the observer will come across the little constellation of Lepus the Hare. Many observers are unfamiliar with this constellation and only stop by to pick up the small globular cluster M79 as they work on their Messier lists. That's a shame because there are at least a half dozen objects here that can easily be picked up even in a small telescope. Two that we will look at in this article are NGC 1832 and NGC 2017.

"Immediately below Orion, the observer will come across the little constellation of Lepus the Hare. Many observers are unfamiliar with this constellation and only stop by to pick up the small globular cluster M79 as they work on their Messier lists."

NGC 1832 is one of the brightest galaxies in this region of the sky, a spiral galaxy viewed face-on. Immediately preceded by a magnitude +9 field star, the galaxy holds magnification well. My 15-inch reflector with a 7-mm eyepiece giving me a magnification of 272× brings out the galaxy well. The galaxy is a moderately bright diffuse object with hazy extremities. The main body is extended due north-south with a bright central region extending to about one arcminute north-south by 45 arcseconds east-west. The spiral arms form faint, unresolved extensions, and at 272×, a faint stellar core is visible, well condensed and well defined.

An intriguing object for the small telescope and visible even under light polluted skies is NGC 2017. Plotted on *Sky Atlas 2000.0* as an open cluster, this object is also designated h3780 and is a

> “ **The constellation Lynx, although well placed for northern observers, is very faint, and its lack of a Messier object means that it is often passed over by most observers.”**

multiple star system numbering eight members. I observed this object from my back yard in Dorval in October of 1992 with my old Schmidt-Cassegrain telescope. Low magnification brought out the four brightest members immediately, and at 161× two additional, fainter members popped into view. The final two members are challenging objects as they are separated from their companion stars by 0.9 arcseconds and 1.6 arcseconds respectively and would require nights of exceptional seeing to locate.

The constellation Lynx, although well placed for northern observers, is very faint, and its lack of a Messier object means that it is often passed over by most observers. There are many galaxies here and at least two objects of particular interest to observers with small telescopes.

The first, NGC 2419, is listed in the *Observer's Handbook* as a challenge object, though one that can be picked up in a fairly small telescope. The easiest way to go about this, particularly if you have an equatorially-mounted telescope, is to centre on the first magnitude star Castor in a low power field of view and then move seven degrees due north. The faint glow of the globular cluster should now be in your field of view. The cluster lies at the eastern end of a line of three magnitude +7 and +8 stars. From the dark skies of Ways Mills, Quebec, NGC 2419 appeared irregularly round with some graininess evident and brighter to the middle. This globular is one of the most distant in the Milky Way family, located 200,000 light years from the sun.

The brightest galaxy in this region of the sky, NGC 2683, is well worth seeking out as it is a bright example of the classic edge-on spiral galaxy. The central region is brighter and bulges slightly, while the extensions are well defined and taper to sharp points. In my 8-inch Schmidt-Cassegrain a very thin dark lane was suspected on the northwest flank.

There is always something interesting to see in the sky, even in areas that are seldom explored. On the next clear night, take out your telescope and go have a look!

Mark Bratton, who is also a member of the Webb Society, has never met a deep-sky object he did not like. He is one of the authors of Night Sky: An Explore Your World Handbook*.*

Simple Pleasures

A Story for New Year's Eve

by Fae Mooney (faemooney@kermode.net)

The weather outside is frightful! No stargazing tonight. From my safe haven indoors I can hear the harsh winter wind tormenting the trees nearby with its menacing howls. Powdery snowflakes swirl in ghostly gusts past the window, horizontally.

It's already dark. Our unseen Sun set hours ago, and the power is out. Here inside, a fire crackles in the fireplace, the living room illuminated by its warming light. Here, it is cozy, warm, safe from the fierce storm. So, we'll have our New Year's picnic inside instead.

In front of the fire we spread a downy patchwork quilt — easier on old bones. The flickering firelight casts strange shadows about the room, and reflects warmly off the cedar plank and beam ceiling overhead. We stretch out in front of the fire, cheeks resting on palms, elbows propped on soft pillows; we watch the flames dart and dance, and forget about the lost opportunity to watch winter's display of stars. Well, we try to forget.

Lounging on our picnic blanket in front of the fire we reminisce about warm summer days that now seem so remote and distant, fair weather picnics, camping trips, summer stargazing, and the Perseid Meteor Shower last August. It's no use, thoughts of a starry night are a preoccupation. The wind howls, and icy pellets of snow tap against the window.

We swap ends, toasting our tootsies in front of the fire for a while. We roll over and gaze up at the shifting patterns of amber firelight glow as they waver over the cedar planks like aurorae in a clear dark sky. The knots in the planks overhead become our stars, and we create in them our own winter constellations and

> **“ Lounging on our picnic blanket in front of the fire we reminisce about warm summer days that now seem so remote and distant, fair weather picnics, camping trips, summer stargazing, and the Perseid Meteor Shower last August.”**

asterisms.

“Look,” I say, “there’s ‘The Broken Dipper.’ Follow the pointer stars to the North Star. Nope, that’s not north, more like south-west. Oh, well.”

Glancing across the ceiling I find ‘The Great Small Square of Pegasus.’ “Over there,” I declare to my mate.

“Nah,” says he, “that’s ‘The Magnificently Magnified Pleiades.’ See that large knot to the left? That’s Aldebaran. And the accompanying ‘V’ formation? Taurus, definitely.”

In our distorted universe, anything goes.

“How about that cluster, poor Cassiopeia,” I lament, “she has been squeezed into a small ‘m,’ no spacious ‘W’ for her throne in our sky.”

We add another log to the fire. It roars into renewed life. Flames leap and engulf one another. We move away from the heat.

Auroral patterns of amber light play on our cedar sky. No moon glows to diminish our stars. No mosquitoes, but then, this is winter.

“Hey, over there,” points my mate, “isn’t that ‘The Southern Cross?’”

“Not bad,” I say, “considering we live next door to the North Pole.”

And we speculate, our imaginations leaping light years away: if we lived on a different planet that orbited a different sun in another part of the Galaxy, what knotty star formations would we see there? Maybe the Gemini twins would be known as Knothead and Splinter!

Firelight dances about the room. The fire crackles and sparks. We cuddle together, gazing at our wooden stars and wonder, contemplate, imagine. Outside, snow swirls in the cold, dark night, but here in front of the fire, it’s cozy, and warm as a summer’s eve. Above our heads an imaginary star field is ours for the naming. We’re free to choose the season, or even the galaxy! It may not be the New Year’s star party we expected, but the naked-eye observing is grand.

The old mantle clock chimes twelve. Midnight — a new year has just begun in a young, new century, and yet another millennium, as we count time. Soon, the fire will fade away to cooling embers and ashes. Our amber aurora will cease its sprightly dance, and the stars in our cedar sky will not endure. But beyond the swirling snow and far above the leaden clouds, perhaps in a future time such strange vistas as we imagined here tonight may be viewed by others, looking homeward, and wistfully dreaming of starry nights once observed on Earth.

A member of the newest centre, Prince George, Fae Collins Mooney is a freelance writer who loves to spend the best part of every day enjoying her natural surroundings at her home in northwestern British Columbia.

ARE YOU MOVING? IS YOUR ADDRESS INCORRECT?

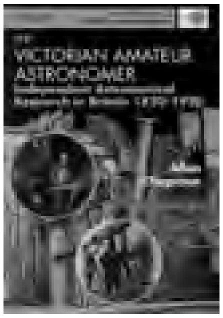
If you are planning to move, or your address is incorrect on the label of your *Journal*, please contact the National Office immediately:

1-888-924-7272 (in Canada)
416-924-7973 (outside Canada)
e-mail: rasc@rasc.ca

By changing your address in advance, you will continue to receive all issues of the *Journal* and *SkyNews*.

Reviews of Publications
Critiques d'ouvrages

The Victorian Amateur Astronomer: Independent Astronomical Research in Britain 1820-1920, by Allan Chapman, pages 428 + xix, 17 cm × 24.5 cm, John Wiley & Sons Ltd., 1998. Price UK£40, hardcover (ISBN 0-471-96257-0).



At the dawn of the 19th century, astronomy was already an enormously complex and wide-ranging scientific discipline. Although it relied almost exclusively on observations to grow and develop, there was a significant theoretical and mathematical component that was being applied to observational astronomy by the continental European scientific community. Such research was almost exclusively state-sponsored but, despite the existence of the Greenwich Observatory, no corresponding initiative could be found in Great Britain. Here, front-line research in astronomy took an entirely different tack, nurtured in large measure by independently wealthy patrons of astronomy. Allan Chapman's *The Victorian Amateur Astronomer* tells the story of how such developments originated as well as describing the enormous contributions made by amateurs to the development of astronomy in Great Britain.

The first part of Chapman's book chronicles the rise and development of the Grand Amateur, a peculiarly British phenomenon that arose from the social and economic conditions of Victorian Britain. Modeled to some extent on the career of Sir William Herschel, the Grand Amateur was typically a well-educated gentleman from the upper echelons of British society. Acquiring his wealth through inheritance, marriage, or commerce, the Grand Amateur typically indulged his passion for astronomy by building the largest instrument and observatory that he could afford. Although some had prior scientific or mathematical training, the majority of them were true "lovers of the sky" and satisfied their thirst for knowledge by becoming premier observers of all astronomical phenomena, from solar and planetary work on up to investigations of the nature of the nebulae.

The president of the Leeds Astronomical Society, H. J. Townsend, with his 9.5-inch reflecting telescope circa 1900. From *The Victorian Amateur Astronomer.*

Although some very familiar names can be counted amongst the ranks of the Grand Amateur — such as Sir John Herschel, William Lassell, and William Parsons, the Third Earl of Rosse — *The Victorian Amateur Astronomer* does a commendable service by bringing to light the names of some lesser known astronomers of the era, such as Dr. John Lee, a patron of astronomy who established a fine observatory at Hartwell House, Aylesbury. The majority of the "lesser lights" usually had access to more modest equipment, primarily because of lesser financial means. Nevertheless, they provided a true service to Victorian-era astronomy, often as popularizers of astronomy (Admiral W. H. Smyth and the Rev. T. W. Webb both published observing guides that are still popular with amateur astronomers today) or as gentlemen who hired assistants to do useful work with the equipment at hand (Lord James Ludovic Lindsay and the aforementioned Dr. Lee).

Front-line research, however, was reserved for the wealthiest of the Grand Amateurs, the so-called "Brotherhood of the Big Reflecting Telescope." Both William and John Herschel had demonstrated the value of large aperture telescopes, and Lassell, Parsons, and James Nasmyth developed instruments along those lines. William Parsons erected two of the largest instruments of the time, 36-inch and 72-inch speculum metal reflectors, clumsy instruments that nevertheless were unsurpassed in sheer aperture until the construction of the 73-inch reflector of

William Lassell's 48-inch equatorially-mounted reflector as it appeared in the year 1861. *From The Victorian Amateur Astronomer.*

The 24-inch reflector built by Thomas Bush, a Victorian amateur astronomer, around the year 1920. From *The Victorian Amateur Astronomer.*

the Dominion Astrophysical Observatory in 1918. Lassell and Nasmyth concentrated on building large, though more manageable, telescopes, and Lassell's equatorially-mounted 24-inch and 48-inch reflectors are notable for their resemblance to the great reflectors that were built in the early 20th century.

An interesting byproduct of the Grand Amateur tradition was that it helped foster instrument development throughout the 19th century, particularly the application of spectroscopy and photography in astronomy. Unencumbered by the demands of accountability to government, educational, or industrial institutions, the Grand Amateur was free to explore various avenues of technology because he was paying for his equipment out of his own pocket.

Part two of *The Victorian Amateur Astronomer* is perhaps the most remarkable section of the book, for here the subject matter deals with the spread of amateur astronomy to the working-class poor of Victorian England. In a series of well developed vignettes we learn of the astronomical lives of several heretofore anonymous amateur astronomers, including John Jones, "the slate counter of Bryngwyn Bach," Roger Langdon, "the Station Master astronomer," and Nottingham baker Thomas William Bush, a telescope maker whose crowning achievement was a 24-inch equatorially-mounted reflector that he built in 1909. Perhaps most interesting of all is John Leach, a poor cobbler on whose behalf the Astronomer Royal, Sir George Airy, intervened to secure a 1.25-inch refractor with which he could continue his studies. In spite of their obvious intelligence, however, most such men never rose above their lowly stations in life, such was the power of the class system of Victorian England.

The third and final part describes the rise of the leisured enthusiast and the establishment of amateur astronomical societies throughout Britain in the latter part of the 19th century. Although the Grand Amateurs of the early 19th century were instrumental in founding the Royal Astronomical Society, it was primarily an elitist and restrictive institution that did not allow women to join until 1916. The British Astronomical Association, established in 1890, as well as earlier regional societies in Liverpool, Leeds, Wales, and Ireland, encouraged middle class as well as female membership and counted women among their most important and active members. There are brief but interesting portraits here of Mary Somerville, Elizabeth Brown, and Agnes Clerke, among others, women who had to overcome institutional biases, to say nothing of social restrictions, in order to pursue careers in astronomy.

The Victorian Amateur Astronomer is a comprehensive and well-researched book that brings to light much information about the development of 19th century amateur astronomy that might otherwise have been lost with the passage of time. The notes and references, as well as the extensive index, account for more than a quarter of the book. Impressive too are the illustrations, eighty of them in all. Although I was familiar with a handful of them, there are many early photographs of amateur astronomers, their instruments, and observatories that are absolutely fascinating. The book is very handsomely produced and there are very few typographical errors.

Although the writing style is somewhat dry and perhaps a tad "academic" for modern tastes, those who have an interest in the history of astronomy will find this volume a welcome and unique addition to their bookshelves.

Mark Bratton

Mark Bratton, the proud owner of a rotary-dial phone and a wooden telescope, is a past-president of the Montreal Centre and a member of the Society's Publications Committee.

The Universe Unveiled: Instruments and Images through History, by Bruce Stephenson, Marvin Bolt, and Anna Felicity Friedman, pages 152, 24 cm × 24 cm, Cambridge University Press/Adler Planetarium & Astronomy Museum, 2000. Price US$29.95, hardcover (ISBN 0-521-79143-X).

The Adler Planetarium and Astronomy Museum on Chicago's waterfront is much more than a place to see an out-of-this-world star show or to explore educational displays and activities. As its full name implies, it is also home to an outstanding collection of historic instruments, images, and documents showing our changing perception of the universe. Three members of the Adler curatorial staff have co-authored this beautiful book which contains nearly three hundred full colour photographs of artefacts from the collection. The book, therefore, would make a very attractive gift or a lasting reminder for visitors to the Adler of its historic treasures. In this reviewer's opinion, that will be its main market, though the authors have clearly intended it for a much broader audience than those who may pass through the planetarium gift shop.

There is a sort of archaeological

theme in the book in that artefacts produced by past generations are a key to understanding how they questioned the universe and looked for answers. So the authors have organized the text around the images that are grouped into four broad chapters. "Discovering Space" attempts to show how constellations, navigational instruments, and telescopes helped people discover the world above; "Discovering Time" deals with the role of sundials, nocturnals, astrolabes, and calendars in tracking heavenly bodies; "Understanding the Earth" is illustrated with terrestrial globes, maps, surveying instruments, clocks, and horoscopes; and finally "Understanding the Heavens" features armillary spheres, orreries, and telescopes as ways people have viewed and found their place in the universe.

The illustrations are not only the backbone of the book, they are its *raison d'être* and its chief delight. I found it mildly annoying to have to flip to the back to find out exactly what is depicted, though the lack of captions does give a very clean appearance to the main pages. The text is definitely relegated to a supporting role — and not a very strong or convincing one. Only about a quarter of each page is text, equivalent to about 35 full pages, so one should probably not expect to get beyond the superficial and trite. Explanations are sometimes so brief as to be useless or even misleading. A neophyte would surely not be able to understand how a quadrant, sextant, or octant operated from the very brief descriptions on pp. 42–43. On p. 91 we read that after the 1830s, "Passengers would have found it too cumbersome and complicated to consult a railway timetable listing local solar times," and on p. 93, "Edmond Halley's strategy of mapping global variations between magnetic and geographic north failed." As an example of less than enticing style, here is the opening sentence of Chapter 3: "As people discovered the universe around them, they sought to understand not only the heavens but the Earth as well."

As the authors point out, the instruments depicted were sometimes status symbols or *objets d'art* rather than useful tools. Perhaps that is not far off the mark for the book itself.

Peter Broughton

Peter Broughton is the Chairman of the Royal Astronomical Society of Canada's Historical Committee and has written many articles on the history of astronomy as well as a book on the Society's history.

Our Universe: The Thrill of Extragalactic Exploration As Told by Leading Experts, edited by S. Alan Stern, pages 152 + viii, 17.5 cm × 25 cm, Cambridge University Press, 2001. Price US$54.95, hardcover (ISBN 0-521-78330-5), US$19.95 paperback (ISBN 0-521-78907-9).

In *Our Universe*, editor Alan Stern has compiled a fascinating collection of astronomy-in-action stories and play-by-play descriptions of the latest intergalactic discoveries. As he states in the introduction, Stern asked the authors "each to tell a personal story involving their own careers and motivations, and to describe some part of a favorite topic in which they had invested long years exploring." By and large they granted him that request and have provided us with unique insights into both the highlights and the daily life of astronomers at various points in their careers.

The authors of the nine chapters have become recognized authorities in their fields, but their writings still retain the youthful exuberance that comes with (or leads to) carving out new territories of research. They cover the following topics: mapping the large-scale distribution of galaxies (J. Huchra); searching for the most distant galaxies (E. Hu); the Cosmic Background Explorer (J. Mather); running cosmological simulations on computer (N. Gnedin); searching for very massive black holes (D. Richstone); explaining gamma-ray bursts (B. Paczyński); clusters of galaxies and the density of the universe (M. Donahue); dark matter and galactic haloes (J. Ostriker); and low surface brightness galaxies (G. Bothun). There is little evidence that the submissions were edited for consistency of style or approach. As a result, the authors' individual styles have been preserved, but the level of technical detail varies. A more significant result is that for some authors we learn about their motivations and obstacles in pursuing a particular field of research, but for others we learn only the results. Personally, I am fascinated by the motivations, since they rarely come to light in scientific publications.

For example, Huchra spends the first half of his essay pondering what makes a successful scientist and recounting how he bounced from topic to topic and from job to job until he "fell into" doing redshift surveys of galaxies, which resulted in the first large-scale maps of the observable universe. Donahue recalls her frustrations with the science teaching she experienced in high school and the difficulties of married-couple astronomers finding jobs in the same city. Her essay is sprinkled with unexpected phrases such as "The concept of working for a physicist blew me away," "Suddenly the work became non-work," "Cosmology was cool!" and the closing sentence, "Sometimes I think we're all born scientists; I was just born lucky too." It seems many of the authors attribute their successes to chance, be it the result of accidental encounters or of being in the right place at the right time. That is probably too modest, bringing to mind Louis Pasteur's saying, "Where observation is concerned, chance favours only the prepared mind."

Some of the other chapters in this book, though less personal, are little gems of scientific distillation, summarizing the state of knowledge in a given field using simple yet evocative descriptions. Especially good essays in this category are Gnedin's explanation of computational cosmology, Richstone's discussion of how black holes affect galaxy rotations, and Ostriker's insights into dark matter. Overall, I am reminded of Donald Goldsmith's

1991 book *The Astronomers* (companion book to a PBS television series), which also emphasized the human side of this oldest of the sciences. Many of the topics are common between the two books, and so are a few astronomers, Huchra and Mather in particular. It is interesting to see what advances have taken place in these hot topics of research over the last decade. Being able to read the exploits of the adventurers in their own words is a definite advantage of Stern's book.

One small disappointment in Stern's book was its poor use of colour. The essays incorporate appropriate line art and monochrome images with the text, but they also refer to colour figures, which (at least in the paperback version) have been collected in two sections totalling twelve pages. They are neither well chosen nor well laid out. At least half of them are unnecessary (a standard photo of a shuttle launch), irrelevant (a drawing of one possible design of the next-generation space telescope), or uninformative (data plots that are too small to read). Closer consultations between editor, authors, and publisher in selecting the images could have improved their appearance and utility considerably.

That minor annoyance aside, I enjoyed the collection of essays immensely. *Our Universe* is a book that is hard to categorize: part memoirs, part history of science (although it describes works-in-progress), and part scientific popularization. But no matter what the label, it makes fascinating reading, especially for those of us who are as keen to learn about the scientists as about the science.

Michael Attas

Michael Attas is a research officer at the National Research Council's Institute for Biodiagnostics in Winnipeg, developing spectroscopic imaging techniques for use in medicine (and occasionally other fields).

Observing the Moon: The Modern Astronomer's Guide, by Gerald North, pages 381 + x, 18.5 cm × 24.5 cm, Cambridge University Press, 2000. Price Cdn$59.95, hardcover (ISBN 0-521-62274-3).

It is difficult to know what to say about this book. The author has invested much time in preparing it, and Cambridge University Press has done an excellent job of reproducing the many fine drawings and photographs included. Yet it leaves me surprisingly flat; I suspect it is a book that will sit on my shelf rarely opened.

The book is strangely lopsided. Its longest and best section, fully half the book, is a set of detailed descriptions of forty-eight selected regions of the Moon, chosen for their topographic variety and interest. Each lunar region is illustrated by photographs and drawings made at various solar illuminations, and North provides descriptive text and an at-the-eyepiece tutorial. The drawings are typical of the British school of lunar drawing: meticulous pen and ink drawings that are striking to look at, but so stylized as to bear little resemblance to what one sees through the eyepiece.

The large section containing the images and descriptive text is preceded by seven short chapters to provide the reader, whom North typifies as an "interested amateur astronomer who is yet to become a lunar specialist," with the background necessary to begin observations of the Moon. After an introductory chapter, there are sections on the history of lunar observation, equipment for visual observation, photography, electronic imaging, the physical nature of the Moon, and reference sources. Following the massive descriptive chapter, there is a chapter on transient lunar phenomena, obviously a subject dear to North's heart. Much of the material is superficial, but it is interlaced repeatedly with rather technical sections, almost as if the author wished to show off his scientific credentials.

When I initially started to read the book, I gravitated to the chapter on reference sources. Clearly North's favourite source is *Lunar Sourcebook — a User's Guide to the Moon*. Unfortunately the book is currently out of print. North lists seven books and maps taken from Sky Publishing's web site, which includes such standards as Antonin Rükl's *Atlas of the Moon*, and then makes an extraordinary statement: "I must admit that I have no personal experience of the adequacy, or otherwise, of any of these items." In other words, he has not bothered to consult a large part of the standard reference works for lunar observers! It was after reading that statement that I seriously began to doubt the quality of the research underlying the rest of the book.

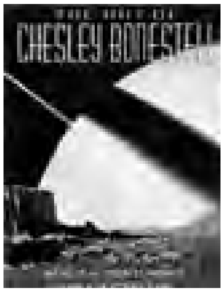
Finally, there is the question of North's writing style. It is what I call the "chatty British eccentric" style, typified by the writing of Patrick Moore and Gerald Durrell. While charming to some in small doses, it definitely becomes tiresome in a long book. Then there is his constant whining about the page limitations imposed on him by his publisher, which he repeatedly uses as an excuse to flog his other book and just about anything else published by Cambridge. It took a major effort of will for me to wade through those portions of the text.

So, what is an amateur astronomer interested in the Moon to do? My favourite book on the Moon, Rükl's *Atlas* mentioned above, is currently out of print, but scheduled to be reprinted by Sky Publishing soon. It is what I always keep at hand while observing the Moon and is well worth seeking out on the used market. I cannot in all honesty recommend North's book to either a beginner or a more advanced student of the Moon.

Geoff Gaherty

Geoff Gaherty has been observing the Moon on a regular basis since he got his first telescope in 1957. His favourite pastime is to play "lunar tourist" at the eyepiece with Rükl's Atlas *as his travel guide.*

The Art of Chesley Bonestell, by Ron Miller and Frederick Durant III, pages 256, 22.5 cm × 30 cm, Paper Tiger, London, Great Britain; distributed in U.S.A. and Canada by Sterling Publishing Co., 2001. Price US$49.95, hardcover (ISBN 1-855-85884-3).



Before humans had glimpsed the planet Earth from space, Chesley Bonestell gave us visionary views of the universe through his hyper-realistic works of art. At a time when space flight was just a romantic adventurous dream, his post-WW II realistic depictions of the Moon, Mars, and Saturn encouraged discussion and debate among engineers and scientists about whether space exploration was indeed possible. Bonestell's views of space travel appeared in hundreds of magazines, including *Life* and *Popular Mechanics*. His art also appeared in dozens of best-selling books, which are now highly sought after by collectors. Here, in a colour-drenched coffee-table sized book entitled *The Art of Chesley Bonestell*, by Ron Miller and Fredrick Durrant, readers can relive the early days of the space program and enjoy a nostalgic look at the inspirational work of a pioneering artist that sparked the imagination of an entire generation.

Anyone with a love of astronomy will be glad to own a copy of this tribute book to the dean of space art. Hundreds of snapshots of extraterrestrial worlds provide a tour of the universe through an artist's imagination. Bonestell had the ability to create astronomical art that was believable and brought planetary and lunar landscapes from enigmatic specks of light through eyepieces at the telescope to worlds with hyper-realistic details that possessed certain familiarity.

The Art of Chesley Bonestell not only covers the artist's famed space-illustrating career, but also provides fine examples of his more Earthly art themes, such as California missions and mythological and antiquarian scenes of Greek and Chinese cultures. More than two-thirds of the book, however, is exclusively dedicated to the artist's extraordinary views of planets, with their craggy rock surfaces and breathtaking vistas.

Bonestell himself is the focus of the first few chapters in a critical biography where the reader soon realizes that the man himself is as fascinating and remarkable as his works of art. Born in San Francisco in 1888, Chesley Bonestell became fascinated with astronomy at a young age when in 1904 he had an opportunity to view the Moon and Saturn through refractors at the Lick Observatory. Although he little suspected it then, that event was pivotal in determining his future career. By the time Bonestell turned to space art professionally in the mid-1940s, he had already been trained and

Bonestell's drawing of a landing on the Moon.

employed as an architect and had worked on important projects such as the Golden Gate Bridge and the Chrysler Building. He also enjoyed a fruitful Hollywood career as one of the most respected and highest-paid special-effects matte artists, working on films such as *Destination Moon* and *War of the Worlds*. Before Bonestell, the planets of the solar system were depicted as "artist's conceptions" in both film and illustrations. With a newfound knowledge of camera angles and perspectives, however, his works took on never-before-seen realism. Bonestell lived a long life up to the age of 98, and was clearly a prolific artist. His works grace many historic publications over the decades.

Miller and Durrant are able to offer a unique perspective in assembling their homage to Bonestell. Ron Miller is a space artist with an international reputation in his own right. His works appear on countless magazine covers and scores of book jackets. Fredrick Durrant is a former leading administrator at the Smithsonian's Air and Space Museum, where he developed its core collection of space art. Durrant had the privilege of being a close friend of Bonestell for many years, and that is evident from the many quotes and excerpts of conversations he had with Bonestell that are scattered throughout the biographical section.

Bonestell's drawing of a manned expedition to Mars.

Bonestell's drawing of Saturn as viewed from the surface of Titan.

Flipping through the Gallery section that makes up the latter half of the book, one finds a compilation of the artist's paintings presented in chronological order. It is here the reader can see clearly the immense number and type of works. All of Bonestell's classics can be found here, including his views of space stations, telescopes in orbit, a manned Mars expedition, and his famous views of Saturn from its satellites. Even though many of Bonestell's works were prophetic, it is readily evident that many of his masterpieces reproduced in this book have a dated appearance. In fact, many were demonstrated to be incorrect as a result of the flotilla of planetary missions that have taken place over the past four decades. Bonestell's single most famous painting, entitled "Saturn as seen from Titan," for example, has a view of a majestic crescent-shaped Saturn hanging in Titan's blue-coloured sky. The *Voyager* flyby of Titan found that the satellite's surface lies beneath a blanket of impenetrable opaque orange haze, however, which makes Bonestell's more romantic view impossible from the satellite's surface.

Bonestell's art played an important role in mankind's exploration of the cosmos and has made an indelible imprint on the evolution of the space age. This book is the first ever mass-market collection of works by the grandmaster of astronomical illustration and will enthrall both longtime fans and the newly introduced with many hours of enjoyment. Even though much of what he painted has turned out to be incorrect scientifically, his images never fail to capture the excitement of space travel and the discovery of unknown places in the universe. Since many alien worlds have not lived up to "Bonestellian" expectations, many admirers of the legendary artist are fond of saying that Bonestell's vision of the universe was the way it ought to have been!

Andrew S. Fazekas

Andrew Fazekas is a science communicator based in Montreal, Canada, who introduces people to the wonders of the night sky through multimedia presentations and star parties. He enjoys collecting space art, from classical pre-spaceflight pieces to modern-day interpretations of various celestial phenomena.

Titles

Authors

Departments

Across The RASC:

Columns:

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

NATIONAL OFFICERS AND COUNCIL FOR 2001-2002/CONSEIL ET ADMINISTRATEURS NATIONAUX

Honourary President	Roy Bishop, Ph.D., Halifax
President	Robert Garrison, Ph.D., Toronto
1st Vice-President	Rajiv Gupta, Ph.D., Vancouver
2nd Vice-President	Peter Jedicke, London
Secretary	Kim Hay, Kingston
Treasurer	Michael S. F. Watson, Unattached member
Recorder	Heide Debond, Toronto
Librarian	Colin Haig, M.Sc., Hamilton
Past Presidents	Randy Attwood, Toronto, and Douglas P. George, M. Eng. B.A.Sc., Ottawa
Editor of *Journal*	Wayne Barkhouse, Toronto
Editor of *Observer's Handbook*	Rajiv Gupta, Ph.D., Vancouver
Editor of *Beginner's Observing Guide*	Leo Enright, Kingston
Editor of *Observer's Calendar*	Rajiv Gupta, Ph.D., Vancouver
Executive Secretary	Bonnie Bird, M.L.Sc., 136 Dupont Street, Toronto, ON, M5R 1V2 (Telephone: 416-924-7973)

CENTRE ADDRESSES/ADRESSES DES CENTRES

The most current contact information and Website addresses for all centres are available at the Society's website: **www.rasc.ca**

Calgary
c/o Calgary Science Centre, P. O. Box 2100, Station "M", Loc #73, Calgary, AB, T2P 2M5

Charlottetown
c/o 38 Mt. Edward Road, Charlottetown, PE, C1A 5S2

Edmonton
c/o Edmonton Space & Sciences Centre, 11211 - 142 St., Edmonton, AB, T5M 4A1

Halifax
P. O. Box 31011, Halifax, NS, B3K 5T9

Hamilton
P. O. Box 1223, Waterdown, ON, LOR 2HO

Kingston
P. O. Box 1793, Kingston, ON, K7L 5J6

Kitchener-Waterloo
c/o Peter Daniel, 36 Talbot Street, Apt. 101, Kitchener, ON, N2M 2A9

London
P. O. Box 842, Station B, London, ON, N6A 4Z3

Moncton
c/o Dr. Francis Leblanc, Departement de Physique et d'Astronomie, Université de Moncton. Moncton, NB, E1A 3E9

Montreal
P. O. Box 1752, Station B, Montréal, QC, H3B 3L3

Centre Francophone de Montréal
C. P. 206, Station St-Michel, Montréal, QC, H2A 3L9

Niagara
P. O. Box 4040, St. Catharines, ON, L2R 7S3

Okanagan
P. O. Box 20119 TCM, Kelowna, BC, V1Y 9H2

Ottawa
P. O. Box 33012, 1974 Baseline Road, Nepean, ON, K2C OEO

Prince George
c/o College of New Caledonia, 3330 - 22nd Ave,Prince George, BC, V2N 1P8

Québec
2000, boul. Montmorency, Québec, QC, G1J 5E7

Regina
P. O. Box 20014, Cornwall Centre, Regina, SK, S4P 4J7

St. John's
c/o 206 Frecker Drive, St. John's, NF, A1E 5H9

Sarnia
c/o Jim Selinger, 160 George Street, Sarnia, ON, N7T 7V4

Saskatoon
P. O. Box 317, RPO University, Saskatoon, SK, S7N 4J8

Thunder Bay
c/o 135 Hogarth Street, Thunder Bay, ON, P7A 7H1

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

Vancouver
c/o Gordon Southam Observatory, 1100 Chestnut Street, Vancouver, BC, V6J 3J9

Victoria
c/o Bill Almond, 354 Benhomer Drive, Victoria, BC, V9C 2C6

Windsor
c/o Frank J. Shepley, 671 Inman Sideroad, RR #2, Ruthven, ON, N0P 2G0

Winnipeg
P.O. Box 2694, Winnipeg, MB, R3C 4B3

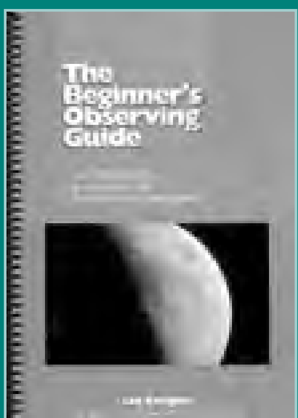
Publications and Products of
The Royal Astronomical Society of Canada

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 that 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

Send cheque or money order to: RASC, 136 Dupont St., Toronto, ON, M5R 1V2 Canada
Please allow 6-8 weeks for delivery. Orders outside Canada please remit in U.S. Funds.
Major credit cards accepted. Call the National Office toll-free at 1-888-924-7272 to place your order.
(These products may also be available directly from your local Centre)