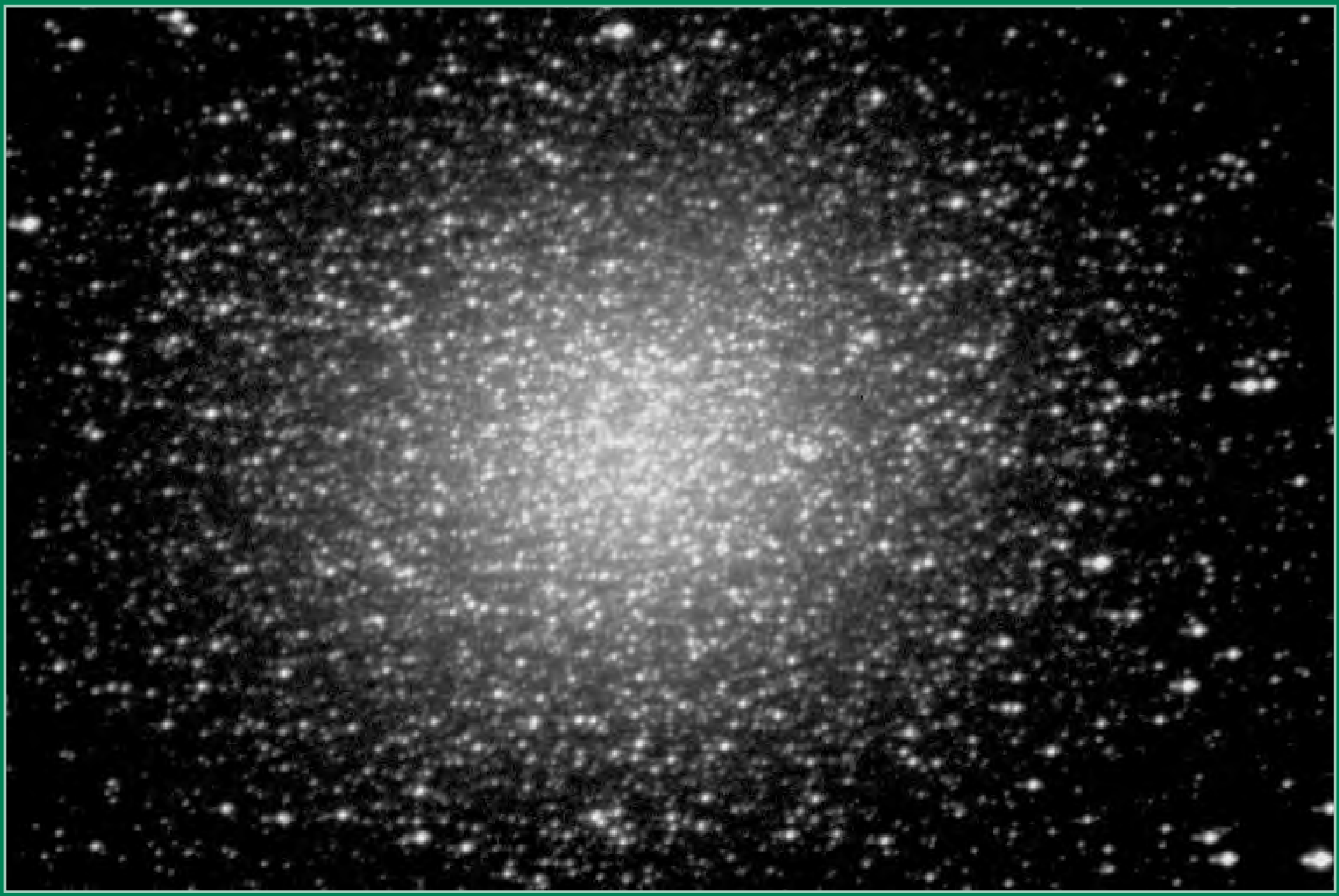
April/avril 2000 Volume/volume 94 Number/numéro 2 [682]

Journal

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



INSIDE THIS ISSUE

Halfway to the Pole • Aztec Calendar Stone • No Fuzzies Observing List
Jovian Thunderstorms • Jan Oort

April/avril 2000

Journal

Vol. 94, No.2 Whole Number 682

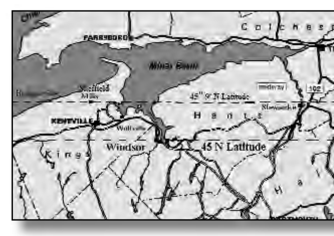
contents
table des matières

FEATURE ARTICLES/ARTICLES DE FOND

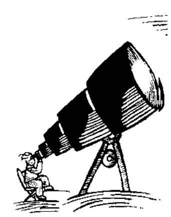
RESEARCH PAPERS/ARTICLES DE RECHERCHE

COLUMNS/RUBRIQUES

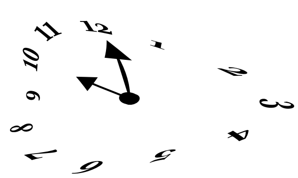
Reflections
p. 53



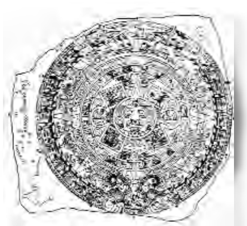
Midway from the Equator to the North Pole
p. 48



Ask Gazer
p. 64



The Winds of Time
p. 52

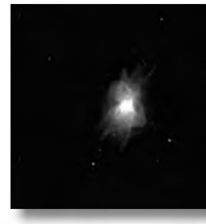


Star Patterns on the Aztec Calendar Stone
p. 56

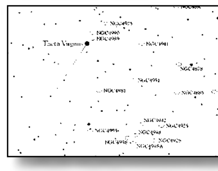
DEPARTMENTS/DÉPARTEMENTS

Book Review
p. 74

Astrocryptic Solution
p. 76



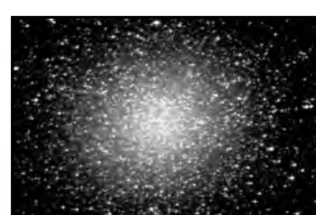
News Notes
p. 46



Scenic Vistas
p. 73

ACROSS THE RASC
DU NOUVEAU DANS LES CENTRES

Cover Photo:
Many Canadian astronomers have returned recently from winter retreats in southern locations. This image of Omega Centauri was taken by Roy Eyematsu and Dave Lane at Florida's Winter Star Party using a 5-inch Astro-Physics refractor and an SBIG ST-7 CCD camera.



President's Corner

by J. Randy Attwood (attwood@istar.ca)

Canadian amateur astronomers are a hearty bunch. Who else would have suffered through −30°C temperatures to observe and photograph the recent total lunar eclipse? That eclipse was a bonus. Where I live, clear skies in January are rare at best, and if it is clear, you can bet it will be a result of a high-pressure system bringing cold temperatures from the Arctic. All week long before the eclipse, the weather did not look promising, although it was hard to keep track because the weather forecast changed every day. First, the forecast was for clear skies. Then it predicted cloudy skies. Then the prediction changed to cloudy with sunny patches. On eclipse morning, total overcast was predicted and I was ready to accept defeat. Then at noon, miraculously the forecast changed and clear skies were predicted. By 6:00 p.m. the Full Moon was rising, the wind speed was increasing, and the temperature was falling. I hurried to set up my equipment, load the cameras, and find more layers of clothing. The eclipse was beautiful. During totality, the Moon took on a three-dimensional appearance. The best views were with low power binoculars or telescopes. They showed the orange-red Moon hanging in space among the stars.

The eclipse proved to be a challenge to photograph. My cameras, cable releases, and telescopes all succumbed to the cold in one way or another. Particular care had to be taken to ensure that a completed roll of film was not rewound until it and the camera were allowed to warm up inside the house. Without such precautions, the brittle film could have shattered.

Readers of this column have been following my reports on the transition that has been taking place at our National Office in Toronto over the past 18 months. The autumn is particularly busy because the majority of membership renewals occur then, and at the same time we accept and fill orders for the *Observer's Handbook*. Our office staff, Bonnie Bird and Isaac McGillis, made it through the hectic period with flying colours. Thanks Bonnie and Isaac!

I am pleased to inform members that the RASC will participate in this year's annual Canada Wide Science Fair in London, Ontario during the week of May 15, 2000. We are sponsoring prizes for projects on astronomy. I hope our participation will continue and that we can offer support and encouragement to aspiring young astronomers.

This year's General Assembly is in Winnipeg on the weekend of June 30–July 2. If you require more information, please visit the GA web site (`http://www.rasc.ca/ga2000/`).

Over the next few months, I am sure you will see reference to a report that has been published regarding Canadian astronomy in the 21st century. It is a report of the National Research Council (NRC)-Natural Sciences and Engineering Research Council (NSERC) Long Range Planning Panel. The report, produced with the participation of the Canadian Astronomical Society

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 one of the addresses given below.

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 1999, $36.00; life membership is $720. Applications for subscriptions to the *Journal* or membership in the RASC, and information on how to acquire back issues of the *Journal* can be obtained from:

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Internet: rasc@rasc.ca
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Telephone: (416) 924-7973
Fax: (416) 924-2911

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

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

"This year's General Assembly is in Winnipeg on the weekend of June 30–July 2. If you require more information, please visit the GA web site (`http://www.rasc.ca/ga2000/`)."

— Société Canadienne d'Astronomie (CASCA), proposes projects that astronomers in Canada could be working on over the next decade. One arm of the plan is public outreach, something that I hope the RASC will participate in. A Web site is planned outlining the proposal; when it is available, we will place a link to it on the Society's web site.

Finally, a Messier update. I am afraid my goal of attaining my Messier Certificate by the year 2000 came up short, however, I finally found some observing time in March under dark skies. After reacquainting myself with the winter Messier objects, I started through Leo and the Virgo cluster for the first time. Given some clear skies over the next few New Moons, I may be able to bag the 35 remaining objects on my list by the summer.

Clear skies!

From the Associate Editor

by Patrick M. Kelly

It is said that a little knowledge is a dangerous thing. Add the power of a computer and the economics of mass production to that, and you can have a genuine recipe for disaster. In the present case I am talking about a recent phenomenon that started in the field of amateur astronomy, and has now spread into the realm of the general public. I am talking about telescopes that contain built-in databases of thousands of celestial objects and use computers to aid in guiding the telescope to the objects.

When such devices first came on the market, they were quite expensive and were aimed squarely at the advanced amateur. They, in turn, were already very familiar with the night sky, and had lots of field experience using their telescopes to find objects. Many of them reached the point where they were actually doing useful science and found that they were spending an unacceptably large amount of their observing time on finding objects, instead of observing them. For those people, the new technology was not a quick way to learn astronomy, it was a quicker way to do astronomy.

As with many pieces of "high" technology, the initial costs for research and production setup are high, resulting in a correspondingly high price, which only the truly dedicated or wealthy can afford. If enough people are willing to part with their money, the initial investment will be recouped. Now, the manufacturer has it "made in the shade." With initial costs recovered, they can now offer the item at a lower price, and enough people have heard of the new "toy" for a ready market to exist. Think of the many examples around you: colour television, VCRs, microwave ovens, air bags, global positioning receivers, anti-lock brakes, the list goes on. Hopefully, soon to be added to the list will be image-stabilizing binoculars!

With the good, though, comes the bad. There are now advertisements in non-astronomy nature and popular science magazines from companies marketing telescopes that come complete with databases of thousands of deep-sky objects. The catch is: the telescopes are 100-mm Schmidt-Cassegrains and 80-mm refractors! Nowhere in the literature does it say that most of the objects that can be easily located cannot actually be seen. What will they have next, binoculars that contain the Hubble Guide Star Catalogue? A spotting scope for bird watchers that tells you when it is pointed towards a California condor or piping plover, regardless of its distance? Imagine the eventual disappointment of someone with a little knowledge of astronomy who decides to purchase a telescope of this type. I am not sure if I should laugh or cry.

One last item. You may recall that in my past editorial I asked you, the readership, for your votes as to what you considered to be the most important astronomical event and/or discovery of the last 100 years and/or the last 1000 years. Well, the results have finally been tabulated and the winner for "event of the millennium" is the *Voyager* missions to the outer planets. Total number of votes: one. I would like to thank the member who participated; he knows who he is.

Correspondence
Correspondance

MOONS OF ASTEROIDS

Dear Sir,

The picture of the moon of the asteroid Eugenia (JRASC, 93, 260, 1999, December) shows the truly remarkable results from the use of adaptive optics on the Canada-France-Hawaii Telescope (CFHT). We now have three confirmed cases of binary asteroids, each discovered by a different technique. A prior example was the discovery of a moon of Ida by the *Galileo* spacecraft in 1993, while, previous to that, the first confirmation dates back to the 1960s — the evidence being the two Clearwater Lakes in Quebec, a pair of large impact structures. Geological evidence indicates that the two impacting bodies were of differing types, and it is not a case of atmospheric fracturing of a single body. An important paper was published in the *Journal* in 1963, entitled "The Orbital Perturbations of a Very Large Twin Meteorite" (JRASC, 57, 109, 1963). In that paper the late R. W. Tanner of the Dominion Observatory showed that a binary asteroid capable of producing the Clearwater Lakes would be stable in the solar system under the perturbing influence of the planets. Thus, the two impact structures clearly represent the impact of a binary asteroid system.

For more than 20 years we astronomers have been flocking to the cluster of fine telescopes on Mauna Kea. In addition to our astronomical images, we usually bring back pictures of the impressive volcanic features on this immense mountain to show to friends. There has been no volcanic activity on Mauna Kea since the time of the pyramids, long before the Polynesians reached Hawaii. There is ample volcanic activity nearby at Kilauea, however, some 50 kilometres to the south. In 1985 Kilauea was erupting about once each month, and I was fortunate to observe one such night-time event from the dome of the CFHT. It was very impressive. How do we know Mauna Kea is also an old volcano? There is abundant evidence in the rocks. And how do we know the Clearwater Lakes represent the demise of a binary asteroid? The evidence is in the rocks.

Ian Halliday, ihalliday@idirect.com
Ottawa, Ontario

MEDICINE WHEELS

Dear Sir,

Regarding the column on "Medicine Wheels" by Barbara Silverman, Montreal Centre (JRASC, 93, 283–286, 1999, December), in 1976 I attended a lecture on medicine wheels by John Eddy of the University of Colorado, at a time when I was director of the H. R. MacMillan Planetarium in Vancouver. It was a highlight of the International Planetarium Society's annual meeting on the campus of that university. (Barbara Silverman refers extensively to Dr. Eddy in the article.) On my return to Vancouver, I determined that we would use the Planetarium, with its ability to reproduce the rising and setting points of the Sun, planets, and stars, to explain these fascinating structures to our audiences.

A crew from the Planetarium, including myself, arranged to visit both the Bighorn (Wyoming) and Moose Mountain (Saskatchewan) medicine wheels at the time of the summer solstice in 1978 so we could photograph the rising Sun and show how the medicine wheels could have been used as an astronomical calendar. In the end we were only able to do that at Moose Mountain. We visited Bighorn a few days later, but by daylight only. What happened at the Moose Mountain medicine wheel on June 21, 1978 was astonishing. It called into serious question the purpose of the wheels, and certainly cast considerable doubt on the hypothesis that Ms. Silverman and others continue to espouse.

To put it bluntly, it does not work! Not in practical terms anyway. The Moose Mountain medicine wheel could not have been used to observe the solstice sunrise, because the hill where it is located slants upward towards the central cairn. If you stand at the rock cairn indicated by Eddy and others as the solstice sunrise sighting position, you are looking upwards, not across to the horizon. We estimated that one would have to be about six metres in height to see across the central cairn to the true northeastern horizon. As a result, even though the sky was perfectly clear that morning, we did not actually see the Sun from the sighting cairn until half an hour after sunrise. By that time its azimuth was considerably to the south of the solstice sunrise point on the horizon.

That is not the only flaw in the hypothesis. With seven outlying rock cairns and the central one, we counted over 56 possible alignments among them at Moose Mountain. If you have the freedom to pick and choose only those alignments that point to the rising and setting points of the Sun, Moon, or first magnitude stars — items that you feel are significant — then you are being highly selective and frankly unscientific. I used to look out from my Planetarium office window in Vancouver at the high-rise apartment buildings on the southwestern horizon. One of them marked the setting point of the winter solstice Sun. Is that significant? Was it placed there for that purpose? Of course not! Yet it worked as a solstice marker. Give me the power to select what alignments I accept and those I do not at a medicine wheel, and I can make almost anything on the horizon seem significant!

Here is another example of the problems with such a line of thinking. Why would the builders of the medicine wheel select an alignment to Aldebaran, a star that is notoriously difficult to see in a reddening sunrise sky? Aside from the issue of precession, the builders would have found it much easier to see the nearby Pleiades. As for the rising point of Fomalhaut, give me a break!

Back in 1978 we had so many questions and were, frankly, so disappointed following our visit to the medicine wheels, that we almost cancelled the planned show. Then we consulted Michael Ovenden, a professor of astronomy at the University of British Columbia, who often advised us on show content. He provided some additional archaeological, astronomical, and statistical insights that cast further doubt on the medicine wheels being used as observatories or calendars. The result was a unique show that presented new visual evidence on the subject. It was quite a coup for a planetarium.

Dr. Ovenden and I attended the University of Calgary's 11th annual Chacmool Conference in October 1978, the theme of which was "Megaliths to Medicine Wheels." I think we caused a bit of a sensation at the time, especially since Dr. Eddy was the chair of the session at which we presented our findings.

Included in our report was an observation that astonished everyone present. It suggested that, in concentrating on the proposed astronomical alignments, we were overlooking something even more interesting — the fundamental outlines of the structures themselves. Ovenden introduced us to the work of the great Scottish archaeologist Alexander Thom, who had discovered, described, and accurately surveyed literally hundreds of stone "circles" throughout the British Isles early in the mid-20th century. Dr. Thom found that he could group all of the so-called circles into just six families according to their shapes. It was as if there were just six basic plans for all of them. Among the families of British stone circles are two that are significant to the medicine wheels in question. One family includes flattened circles. Big Horn is a perfect geometrical match. Another involves egg-shaped ones. The Moose Mountain medicine wheel belongs to that family.

Why the designers and builders of those two medicine wheels on the North American plains should adopt such unusual shapes remains a mystery. We know from observations of other stone circles that when they wanted to create a perfect circle, they could. Why the shapes of the Big Horn and Moose Mountain medicine wheels should so closely resemble the unusual shapes of British stone circles is even more compelling. One is tempted to wonder if there might have been some prehistoric contact between the stone builders of Britain and those of the plains, but that is very far-fetched. We will likely never have the answer.

People can believe what they want, but they should beware of wishful thinking about the medicine wheels. We may wish to believe that the pre-Columbian plains Indians were sophisticated observational astronomers, and perhaps they were, but that does not mean that the medicine wheels were their observatories. I know what we saw on the solstice morning of 1978, and what we did not see, and we have the photographs to prove it. Unfortunately, our observations had very little impact, obviously, since some people continue to hold to the other view.

David A. Rodger, darodger@istar.ca
North Vancouver, British Columbia

GREAT ASTROPHOTOS WANTED

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

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

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

Contact Dave Lane (dlane@ap.stmarys.ca) or the editors (address can be found on the masthead at the beginning of this magazine).

News Notes
En Manchettes

YUKON FIREBALL

On January 18, 2000, sensors on board U.S. Department of Defense satellites detected the impact of a meteoroid at 16:43:43 UTC (8:44 a.m. local time) near Whitehorse, Yukon Territory. The object detonated at an altitude of 25 kilometres at a location of 60°.25 N, 134°.65 W. Optical sensors detected the same event at 16:43:42 UTC. The optical event lasted two seconds in the 1-micron wavelength band used for detection. The estimated total radiative power of the event (for an assumed 6000 K blackbody model) is 1.1×10^{12} joules, which, for an assumed energy conversion of 10%, corresponds to an equivalent total energy of approximately 2–3 kilotons of TNT.

What have been identified as pieces of the meteoroid were found on the frozen surface of Tutshi Lake in northern British Columbia. They are now being tested and appear to be carbonaceous chondrites.

PLANETARY NEBULAE REVEAL ORGANIC MOLECULES

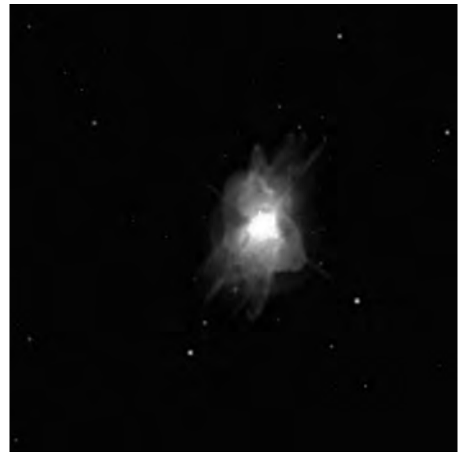
In the past few decades our search for the origins of life has slowly turned skyward. With the discovery of organic (carbon-based) molecules in interstellar gas, comets, and meteorites, it does not seem out of the question that the seeds of life, or even life itself, may have originated in space. Now a group of researchers from Canada and the United States has found a new source of cosmic organic molecules. Although the organic molecules in question are not the complex compounds found in known life forms, under the right conditions they could form amino acids, which are one of the building blocks of life.

The team used the European Space Agency's *Infrared Space Observatory* to detect organic molecules in gas shells — in particular, planetary nebulae — surrounding old stars. Sun Kwok and Kevin Volk (University of Calgary) and Bruce Hrivnak (Valparaiso University) announced their results on January 12th at the Atlanta meeting of the American Astronomical Society.

During their final stages of stellar evolution, many red giant stars can create a planetary nebula consisting of an expanding shell of gas surrounding a hot compact star that represents what remains of the former core of the precursor star. The interval between the end of the star's red giant phase and the development of a full-blown planetary nebula spans only a few thousand years. Through examination of the infrared signatures of many stars at different evolutionary stages of the process, Kwok and his team have found that the progression from red giant to planetary nebula includes a relatively rapid period of chemical synthesis of molecules.

According to the group's observations, simple aliphatic organic molecules such as acetylene (C_2H_2) are formed during the red giant stage of highly evolved intermediate-mass stars. Aliphatic molecules, of which methane (CH_4) is the most common organic example, do not form a ring structure. Once a planetary nebula becomes more fully developed, however, larger, more complex, aromatic (ring structure) molecules like benzene (C_6H_6) do begin to appear in the planetary nebula shells. As the planetary nebula gradually expands, such molecules are carried into interstellar space, where they may later be swept up by planets surrounding distant stars. Further chemical reactions could produce amino acids, then proteins, and — ultimately — life.

Kwok and his team suggest that amino acids themselves might even be formed in such a cosmic chemistry laboratory. To find them, astronomers will need new and more sensitive space telescopes.



Organic molecules were found in this proto-planetary nebula, nicknamed the Water Lily. Located in the constellation of Ara, the nebula was imaged by the Wide Field Planetary Camera 2 on the *Hubble Space Telescope*. Photo credit: Sun Kwok, Bruce Hrivnak, and Kate Su.

GRAVITATIONAL LENS PROBES QUASAR

Einstein's universe is a strange and yet wonderful place. According to the theory of general relativity, as light passes through a gravitational field it is deflected in the direction of massive objects. The result can be a gravitational mirage, the distorted view of luminous background objects viewed along the direction of massive sources. For years now astronomers have detected lovely examples of gravitational mirages. One such object is Q2237+0305, also known as Einstein's Cross. Situated in the constellation of Pegasus, it contains four closely spaced images of the same distant quasar viewed through the nucleus of an intervening spiral galaxy.

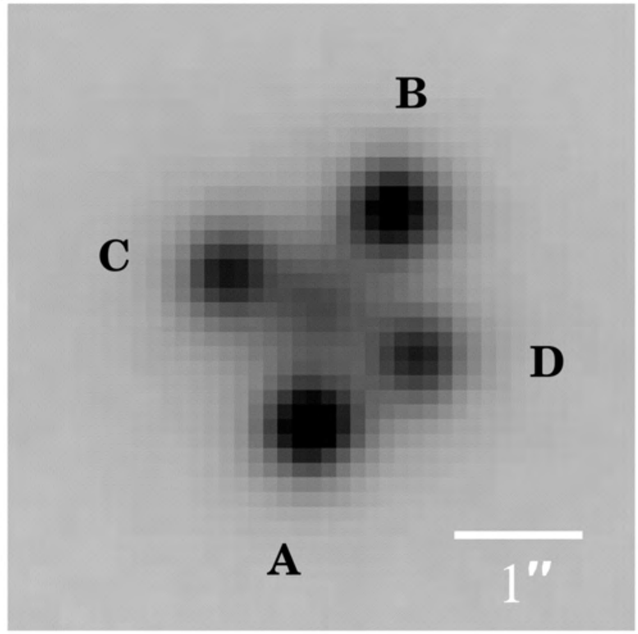
A team of Canadian astronomers has now used Einstein's Cross much like a gigantic magnifying glass to probe the characteristics of the distant quasar. Daniel Nadeau, René Racine, René Doyon, and Geneviève Arboit, all from the Université de Montréal, used the Canada-

France-Hawaii Telescope to monitor changes in the brightness and spectral characteristics of each component of the Cross (Dec. 10, 1999 issue of the *Astrophysical Journal*). The team obtained their observations of the quasar between 1991 and 1994 using the Montreal Infrared Camera (MONICA).

Acting much like a telescope, a gravitational lens magnifies the brightness of background objects, making the nearly invisible visible. At the same time, individual stars in the intervening galaxy can act as microlenses that magnify particular regions of the quasar. As the stars move across the line of sight, the individual components of the mirage change in brightness.

Generally speaking, a gravitational lens does not favour any particular wavelength. A microlens can selectively magnify discrete regions of a background quasar, however, and, if those regions have different radiation characteristics, then different sections of the mirage will have different spectra.

During the period between 1992 and 1994, the Université de Montréal team found that the observed light variability in individual components of Einstein's Cross was "achromatic" in character. In other words, the components displayed no obvious differences in colour, a crude measure of the spectral characterics. In September 1991, however, changes in brightness between components *A* and *B* of the Cross were also accompanied by dramatic colour, or spectral, variations. The characteristics of the observed changes implied that the foreground microlenses were sampling a thermally radiating accretion disk on the lensed quasar, presumably surrounding a supermassive black hole. The team's results tend to contradict models for the environment immediately surrounding a black hole in which the black hole is surrounded by optically thin cloudlets, as well as models in which there are hot spots in the black hole's accretion disk. Neither model predicts that changes in the brightness of lensed components will display telltale colour shifts.



A Canada-France-Hawaii Telescope infrared image of Einstein's Cross taken in the light of $H\alpha$ by the MONICA camera under 0.62 arcsecond seeing conditions. The image is an average of selected data from 1992 and 1994. North is up and east is to the left. Image credit: Daniel Nadeau, René Racine, René Doyon, and Geneviève Arboit.

ASTEROIDS WITH CANADIAN CONNECTIONS

(3666) ENSAB = 1993 OZ2

Discovered 1993 July 23 by C. S. Shoemaker and D. H. Levy at Palomar. Leo Enright (b. 1943) and Denise Sabatini (b. 1950) of Ontario are one of the foremost couples in Canadian amateur astronomy. Leo is an accomplished solar and auroral observer and has written the *Beginner's Observing Guide*. Denise's interests centre on archeoastronomy and in providing access to astronomy for the disabled.

(10332) DÉFI = 1991 JT1

Discovered 1991 May 13 by C. S. Shoemaker and D. H. Levy at Palomar. Défi Corporatif Canderel is a fundraising event for cancer research programs at universities in Montreal. Founded by Jonathan Wener, the event has been directed by Gerald Levy since its inception in 1990. It features a costumed run through the streets of Montreal, and has raised more than three million dollars.

11955) RUSSROBB = 1994 CA1

Discovered 1994 February 8 by D. D. Balam at the Dominion Astrophysical Observatory, Victoria. Russell M. Robb (b. 1952), astronomer at the University of Victoria, played the leading role in automating the university's 0.5-m telescope and equipping it with a CCD camera. The telescope has been used extensively in the university's observational programs, including astrometric work on comets and minor planets.

(12513) NIVEN = 1998 HC20

Discovered 1998 April 27 by P. G. Comba at Prescott. Ivan M. Niven (1915–1999) was a Canadian-U.S. mathematician who worked mainly in number theory. In 1943 he completed the proof of Waring's conjecture, a conjecture formulated in 1770 to the effect that every positive integer is the sum of a finite number of *n*-th powers of integers.

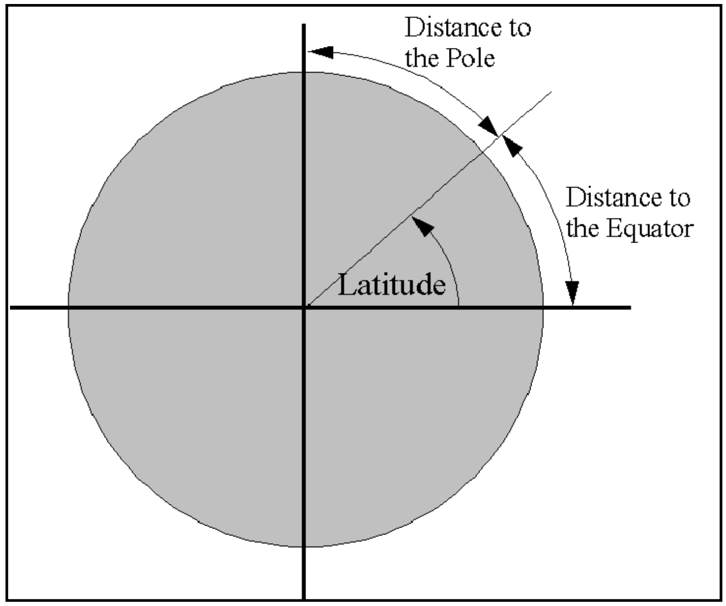
Midway from the Equator to the North Pole

by Larry Bogan (larry.bogan@acadiau.ca)

Several years ago there was a small controversy in Nova Scotia concerning the correct location of a highway monument near Stewiacke, Nova Scotia. In the 1930s, a roadside marker along Route 2 was erected to indicate that it was one place in Nova Scotia that is midway between the North Pole and the Equator. That marker was 16 kilometres north of the 45th parallel, where some people felt it should be located. The old marker is correct, and if you are driving south on Highway 102 toward Halifax, you will see another sign just north of exit 11 to Stewiacke announcing that you are at that unique line of latitude: 45° 8´.65 N, midway from the pole to the equator.

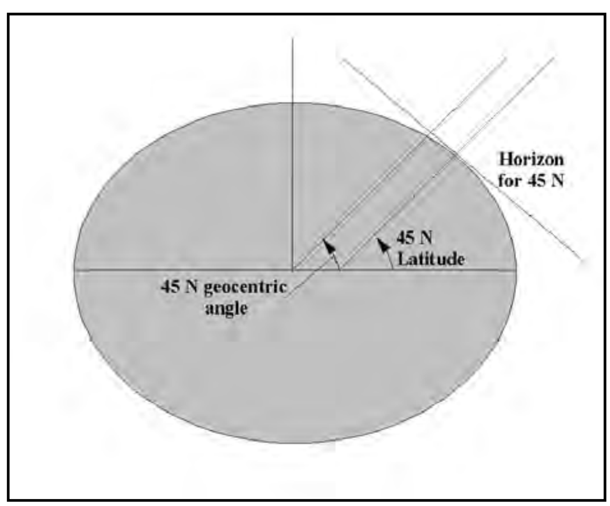
The controversy occurs because a midway point can be defined in a couple of ways. The most obvious definition is to use a point on the 45th parallel (45° N), which is the latitude numerically midway between the Equator at 0° N latitude and the North Pole at 90° N latitude. The correct method, however, is to halve the distance along the surface of the Earth between the Equator and North Pole. The latter procedure involves more difficult calculations than is the case with the first definition. Only if the Earth were a perfect sphere would the midpoint specified by both methods occur at 45° N latitude. What is the difference?

The Earth is not a sphere but an oblate spheroid. The surface at the poles of the Earth is one part in 298 closer (21 km) to its centre than is the surface at the Equator. If the Earth were not rotating, it would be nearly a perfect sphere, but since it rotates once every 23 hours and 56 minutes, the gravity that holds the stuff of the Earth together must also provide the force to keep the various parts of the planet going in circles. As a result, there is less force to hold the planet together at certain locations, the most extreme situation being that at the Equator.



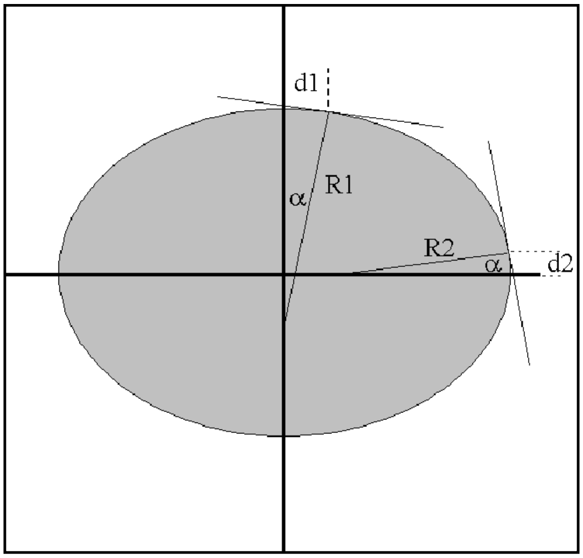
Because of the resulting reduction in the net force at the Equator, the rock and water there extends farther from the centre of the Earth than the material at the poles. An alternate way of describing the effect is used if you take the point of view of someone rotating with the Earth. In our rotating system, a fictitious centrifugal force acts perpendicular to the rotation axis and proportional to the distance from the axis, and is proportional to the square of the Earth's rotation rate. Such a force is greatest at the Equator, where it reduces the net force on the Earth at this longitude. That allows material at the Equator to move even farther from the rotation axis of the Earth.

What is the consequence of the non-spherical shape of the Earth on the halfway point?



Latitude:

Latitude on the Earth is defined as the angle between a plumb bob and the equatorial plane of the Earth. A plumb



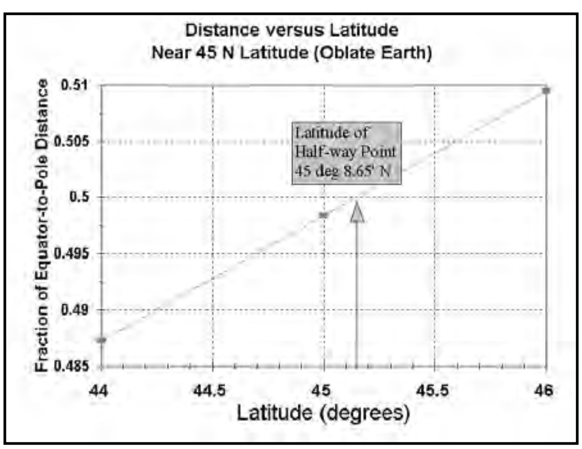
bob hangs perpendicular to the surface, and in the case of a non-spherical Earth does not point towards its centre. The effect can be visualized by the following example. Take a flexible sphere (rubber ball) and squeeze it between two parallel boards so that it takes the shape of an oblate spheroid (flattened sphere). Before the sphere was compressed, the point midway between equator and poles was at 45 degrees. After the ball was compressed, the point on its surface at which 45 degrees occurs is closer to the equator of the ball. The midway point on the ball has not moved, only the "latitude" on the ball. As a result, the midway point is farther from the equator than the 45 degree point.

The flattened areas near the poles of the Earth are curved less than the area near the equator. The smaller "curvature" means that the radius of curvature of the surface is larger. As a result, the required distance along the surface needed to produce a change of one degree in latitude is larger near the North Pole than near the Equator, where the radius of curvature is smaller. That is illustrated below. The shape of the Earth has been measured by various surveys, and its curvatures are known. It is necessary to know the shape in order to determine your location on the Earth. The *Observer's Handbook* gives an approximate relationship to calculate the distance required to change one degree of latitude at any latitude (see p. 25 of *Observer's Handbook 2000*, edited by Roy L. Bishop, The Royal Astronomical Society of Canada):

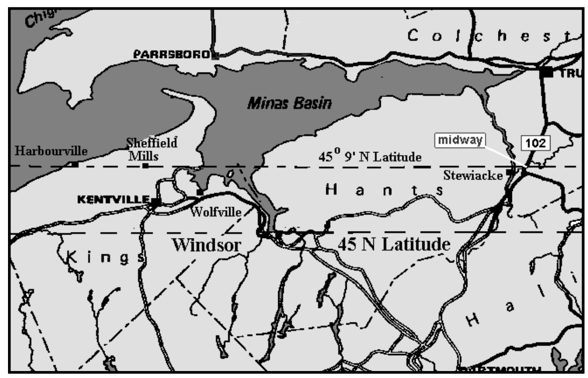
$$1° \text{ of latitude} = 110.575 + 1.118 \sin^2\phi \text{ kilometres},$$

where ϕ is the latitude on the Earth where the distance of one degree latitude is measured. (Note: In the *Handbook*, the second co-efficient is quoted to be 1.110, but the author finds it should be 1.118.) At the Equator ($\phi = 0°$) the mean distance between 1° lines of latitude is 110.575 km. At the poles ($\phi = 90°$) the mean distance between 1° lines of latitude is 110.575 km + 1.118 km = 111.693 km.

By summing the distances for each degree of latitude from the equator to the pole, the distance along the surface can be determined. The required fraction of the distance between the Equator and Pole is then determined as the fractional amount of the total distance. The results are depicted in the graph below for those latitudes near 45° N. Note that the halfway point is not at 45° N, but falls slightly north of that parallel. Halfway is determined to be at 45° 8′ 39" of latitude. Above is a map of central Nova Scotia showing 45° N latitude as well as the parallel (45° 9′ N) on which you will be halfway between the Equator and the North Pole. Some local communities that lie on or near the latter line are Harbourville and Sheffield Mills. The line also runs just north of the town of Canning. There are many other locations in Canada that are midway between the North Pole and the Equator. The author lives at 45° 5′ 14" N and can say that he lives north of the 45th parallel but closer to the Equator than the pole.



The fact that a plumb bob hangs perpendicular to the surface of the Earth has another interesting effect that is largest at the midway point to the pole. The plumb bob does not point towards the centre of the Earth. It also means that the zenith is not directly away from the centre of the Earth. At 45° N (or S) the direction of the local zenith lies 6′ of arc away from the line pointing away from the centre of the Earth. The drawing below illustrates the relative positions near 45° N of the midway point and the direction to the centre of the Earth.



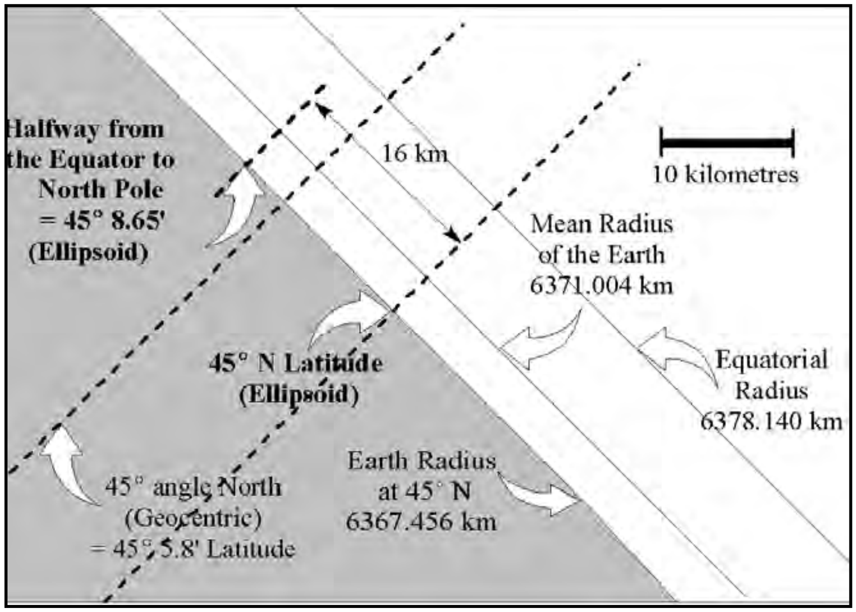
Final Complications:

The discussion in the previous paragraph assumes that the local plumb line hangs perpendicular to the ellipsoid of the Earth. The ellipsoid is the simplest mathematical convenience on which to base our latitude and longitude system, but it does not describe the local shape of the Earth. Generally the local plumb line does not match exactly that of the reference ellipsoid, and since astronomical latitude and longitude are determined by the local plumb line, transformations are necessary

[1] WGS84 uses an ellipsoid with the equatorial radius of 6378.137 kilometres and a polar radius of 6356.752 kilometres. It has nearly the same flattening as IAU 1976, but the axes are 3 metres smaller.

to convert to Earth co-ordinates.

There is no one unique reference ellipsoid and the one used here and referred to in the *Observer's Handbook* is the one defined by IAU 1976. If you use a Global Positioning System (GPS) in North America, you will most likely be determining your position with respect to the WGS84[1] reference ellipsoid. Most GPS receiver units are able to convert between many different reference ellipsoids. The whole subject of the shape of the Earth and co-ordinate systems is too complicated to go into here. Some references listed below provide more details on the subject.



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Jean Meeus, 1991, *Astronomical Algorithms*, Chapter 10, The Earth's Globe (Willmann-Bell, Inc.: Richmond, Virginia)

Larry Bogan is a member of the Halifax Centre RASC living in Cambridge Station, Nova Scotia, a rural area where there used to be dark skies (encroaching commercial areas and yard lights are destroying them slowly). He earned a Ph.D. in physics from Cornell University, and subsequently taught at Acadia University as well as the University of Connecticut. Currently retired from Acadia, Larry still dabbles in teaching astronomy over the Internet. He is a founding member of the Minas Astronomy Group in Wolfville. His main telescope is a 33-cm Dobsonian, however he has also owned a 15-cm telescope since grade 11. He is a glider pilot, and part owner of a sailplane, and loves soaring, especially using GPS to track his flights. He also enjoys computer calculations related to astronomy, especially orbital mechanics, and provides the Configuration of Saturn's Brightest Satellites section for the Observer's Handbook. *In recent years Larry has done some photometry of asteroids, and hopes to do more.*

A Lamplighter Moment[1]:

Astronomy through the Windshield

by Michael Attas (Michael.Attas@nrc.ca)

"How can the Moon and Sun both be in the sky at the same time, when they should be exactly opposite each other?"

"Why do lunar eclipses only happen when the Moon is full?" Our family debated that question at the dinner table and quickly resolved it. The next question, "Why is there not an eclipse with *every* Full Moon?" was resolved almost as quickly. But another question popped into my head on the way home the evening of January 20, a few hours before the first eclipse of 2000 was due to start. As I left Winnipeg heading northeast, I saw the Full Moon rising well before the Sun had set. I had always imagined the Earth being at the fulcrum of a giant celestial seesaw when the Moon was full, so that the Moon would rise precisely as the Sun set. "How can the Moon and Sun both be in the sky at the same time, when they should be exactly opposite each other?"

Pondering that question led me to another episode of Windshield Astronomy. For the previous investigation I was merely the writer while my colleague Jude McMurry made the observations and documented them photographically (JRASC, 93, 163, 1999, August). Now I have joined the ranks of long-distance car-poolers. My early-morning drives west from Pinawa to Winnipeg and back in the evenings are excellent opportunities to observe the sky, ponder our place in the universe, and remember why some of us choose to live on the cold, flat, clear, dry Prairie. Late last year a parade of planets, including Mercury, was visible in the morning and evening skies. A few days ago a pair of fiery sundogs lit up the icy sky. Now we were only hours away from a major celestial event, and a minor celestial mystery needed solving.

Time to make some measurements, or at least estimates. (Drat, I wish I wasn't driving!) Out the right window, the Moon was about one diameter above the horizon, at the same time as the Sun was about one diameter above the horizon out the left window. A few minutes later (jeez, I should have timed it!), the road turned and I had a better view of the Moon, but I had to use the rearview mirror to check on the Sun's descent. When the Sun finally disappeared below the horizon, the Moon was about four diameters up — and what a beautiful Moon it was! It lit my way home, surfing the purple edge of the Earth's giant shadow as it climbed higher and higher.

I tried some rough mental calculations. How fast does the Moon move in the sky? Relative to the horizon, one full circle a day is a fair approximation. I remembered that the Moon and Sun each appear about half a degree across.

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

So thanks to the Earth's rotation, they move westward about 360 degrees in 24 hours, or 15 degrees an hour, or 30 diameters an hour, or one diameter every two minutes. The Moon's revolution about the Earth takes a month, 27.32 days relative to the stars, so the Moon also moves eastward 13 degrees per day, or about one Moon diameter every hour. Since totality was still five hours away (10 p.m. versus 5 p.m. CST), the Moon at sunset/moonrise would be about five diameters ahead of its position (relative to the sky) at the exact moment of opposition (mid-eclipse). Pulling it down five diameters would put it just below the horizon at the moment the Sun had finished setting. Given that our landscape is almost as flat as that of Regina (a longstanding Prairie rivalry), that was close enough to satisfy me.

But there was another niggle. My first observation found both Sun and Moon one diameter above the horizon at the same time, but that was incompatible with the second observation. I was puzzled for a while, until I remembered that, because of refraction in the atmosphere, we can see the Sun and Moon above the horizon even after geometry tells us they should have set. (Russ Sampson has modeled the phenomenon in the February issue of the *Journal*.) How large is the effect? My data suggest at least one diameter[2]. To measure the size of the effect more accurately would take more careful observations, probably requiring me to stop the car, which is against the rules of Windshield Astronomy.[3]

The eclipse later that evening was indeed spectacular, but for me the "Lamplighter Moment" had been at moonrise/sunset, when I could see the Earth sitting directly between the two other celestial bodies. Music of the Spheres indeed!

After seventeen years with Atomic Energy of Canada Limited, Michael Attas recently joined the National Research Council's Institute for Biodiagnostics in Winnipeg. There he struggles daily to develop new applications of infrared imaging and spectroscopy to diagnosing medical problems. In his spear time, hep roofreads the RACS's Journal.

[2] The actual amount of refraction at the horizon amounts to about 33 arcminutes, which is indeed the rough equivalent of one solar or lunar apparent diameter. — Ed.

[3] When I mentioned my adventure to Dr. McMurry, she commented as follows: "I see that by now you are well initiated into the Order of Commuter Skygazers. My only concern is that you could use a co-pilot for some of your travels, when the heavens overwhelm the highways, to make the roads a little safer for those of us coming at you head-on."

The Winds of Time

(Words written for a song composed by the author that is a reflection on time and loss)

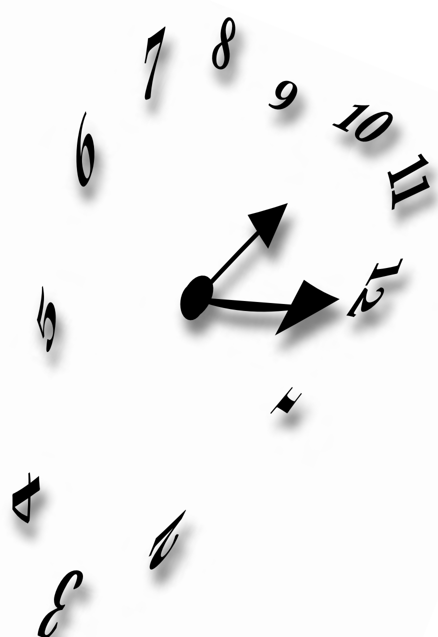
by Christine Kulyk (clkulyk@kos.net)

The winds of time
Are blowing faster now,
And every year
Seems to hurry by somehow;
As winter nights
Draw closer, you will see
I will return
If you remember me.

Our lives, like starlight,
Flicker in the breeze;
We fill each day
With enchanted memories.
While smiles and tears
Change places suddenly,
I'll still return
If you remember me.

Though northern lights
Always fade and disappear,
The light within
Grows much stronger every year;
The more we live,
The more this life can be —
Time will return
When you remember me.

And so, my friend,
You will see the fates allow
That what we love
Seems to carry on somehow —
Through all creation's
Perfect symmetry,
Love will return
When you remember me.



Christine Kulyk has been an RASC member off-and-on since the late 1960s, when she joined the Montreal Centre as a teenager. A native Montrealer, she attended McGill University, where she majored in physics and mathematics, then moved to Edmonton, where she graduated from the University of Alberta with a B.Ed. and a B.A. in English. She served as Treasurer of the Edmonton Centre for several years. After spending a few years in Toronto, she moved to Kingston nearly ten years ago and joined the Kingston Centre, where she has been a past President and Vice-President. She is a full-time freelance writer and editor, currently Assistant Editor of SkyNews *and a researcher/writer for* Equinox.

Jan Hendrik Oort — *Swirling Galaxies and Clouds of Comets*

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

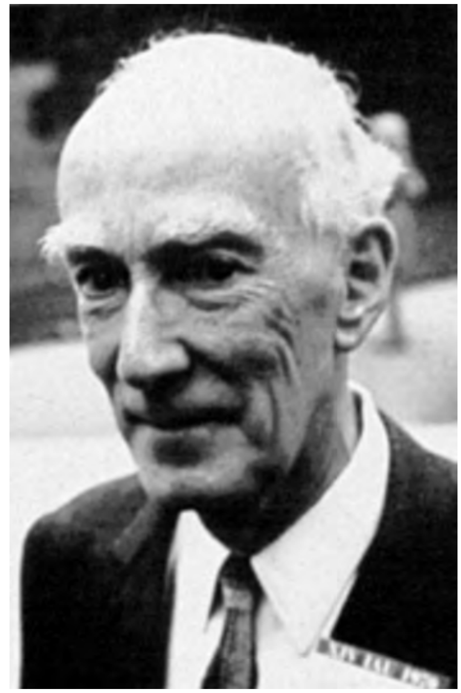
In an astronomy word-association test, the stimulus "Oort" invariably elicits the response "cloud," referring to the currently-accepted source of long-period comets: a distant and broad region of the solar system, a thousand times more distant from the Sun than Pluto, the outermost planet. Before I did some background reading for this article, that was about the extent of my knowledge of the origin of comets and the man whose name has become associated with them. What I discovered was that there is more to Jan Oort than comets, and more to cometary origins than Jan Oort!

Jan Hendrik Oort was a Dutch astronomer, born 100 years ago on 1900 April 28 in Franeker, The Netherlands. He studied at Gröningen University under Jacobus Kapteyn and — apart from a brief two-year stint at Yale — remained in his native country for the rest of his life, working at the University of Leiden. His publication record spans an impressive 70 years: 1922–1992. Oort's principal research interests were the structure of our Galaxy and the large-scale structure of the universe itself. By examining statistical data on stellar motions, he deduced not only that the Galaxy rotates, but that the rotation is differential, that is, the Galaxy does not rotate as a rigid, solid body. Rather, the angular velocity of stars around the galactic centre varies with the radial distance from the centre. That is in accordance with Newton's laws of motion and Newton's law of gravitational attraction. Oort's studies confirmed that the same laws remain valid over galactic distance scales. By observing how the angular velocity of the galaxy varies with distance from the centre, one can actually deduce the distribution of mass in the galaxy. From Oort's early analysis, it became clear that our Galaxy consists of a large globular central condensation surrounded by a disk of matter.

In the post-war years, Oort and others also investigated the spiral structure of our Galaxy, surveying the mass distribution with radio telescopes tuned to the 21-cm hydrogen emission line. When one looks at a photograph of a spiral galaxy, it is tempting to imagine the whole thing rotating as a giant, lazy pinwheel. In fact, the spiral arms are simply local condensations in the galactic matter, regions where the density of stars, gas, and dust are higher than average. These arms travel as waves around the galaxy, while the individual stars within them go on their merry way, in orbit within the gravitational potential well formed by the Galaxy's mass. In effect, the spiral arms are sound waves in the galactic "fluid."

In 1942, the Astronomical Society of the Pacific awarded Jan Oort the Catherine Wolfe Bruce medal for lifetime contributions to astronomy. Since he was only in his early forties at the time, with many achievements yet to come, that was remarkable! An extensive obituary of Jan Oort appears in the *Publications of the Astronomical Society of the Pacific*, 105, 681–685, 1993, July. It is available on-line through the links contained in a brief biography of Oort at `www.phys-astro.sonoma.edu/BruceMedalists/index.html`. Members of the RASC may be interested in knowing that the Bruce Medal was awarded for the first time in 1898 to Simon Newcomb, a Nova Scotian who became a famous and influential American astronomer. The RASC has named its astronomy-writing award after Newcomb.

Oort's comet connection did not arise until 1950. Elaborating upon earlier work by the Estonian astronomer Ernst Öpik and fellow Dutchman Adrianus van Woerkum, Oort again applied statistical analysis to the orbital elements of comets. Looking at the eccentricities, aphelia (points farthest from the Sun), and inclinations of the so-called long-period comets, Oort deduced that their source was a cloud of up 10^{12} comets about 50,000 A.U. from the Sun (more of a shell, really). Needless to say, objects at such distances are barely moving, and are very weakly bound to the Sun. Oort's hypothesis proposed that — once in a while — the barest nudge from a passing star could gently send a comet nucleus on a slightly perturbed orbit toward the Sun, allowing it to pick up speed over thousands of years, eventually making a blazing pass through the inner Solar system, only to return to the cold, dark cloud whence it came. That model (and variations on it) is the reigning explanation for the source of long-period comets. A similar proposal was advanced by the Dutch-American astronomer Gerard Kuiper for the source of short-period comets, although in the



Dutch astronomer Jan Oort (1900–1992).

latter case he imagined a disk of material beyond the orbit of Neptune in the 20–100 A.U. range. An excellent treatment of the Oort cloud and the Kuiper Belt can be found in Donald K. Yeomans' *Comets: A Chronological History of Observation, Science, Myth, and Folklore* (Wiley: New York, 1991).

With regard to the terms "long-period comet" and "short-period comet," I have not been able to find a uniform opinion on the dividing line between the two. I think it is safe to say that comets with orbital periods of 200 years and up are considered long-period comets, leaving those with periods of less than 200 years to be considered as short-period comets. With such a definition, short-period comets inhabit that portion of the solar system within the orbit of Pluto, whose period is 248 years — although the "long" short-period comets may spend some time just outside Pluto's orbit, as comet orbits tend to be elongated ellipses and most of a body's life is spent at the aphelion end of the orbit, rather than the perihelion end. The capacity for human beings to categorize and subdivide is infinite, so it is no surprise that some authors have introduced the term "medium-period" comets for those comets with periods in the range 20–200 years. In any case, there appears to be evidence for a natural division between those comets that spend a great deal of time interacting gravitationally with the planets in the solar system (notably Jupiter) and those that lurk about in the distant reaches of the Oort cloud. In fact, it is viewed that the current crop of short-period comets were supplied by the Oort cloud and "captured" by interacting with planets such as Jupiter. The recent Comet Hale-Bopp is a good example of a long-period comet, while Comet Halley is a short-period comet (or a medium-period comet for those who need the extra category).

The literature on the origin and orbital history of comets is vast and fascinating, far too complex for me to condense into a *Reflections* column. I hope that I have at least whetted your appetite for the subject of comet clouds, the man who lent his name to the hypothesis, and his other achievements. Personally I am fascinated by comets, as may be evident to regular readers of this column. I can hardly wait for the next visitor from the Oort cloud!

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

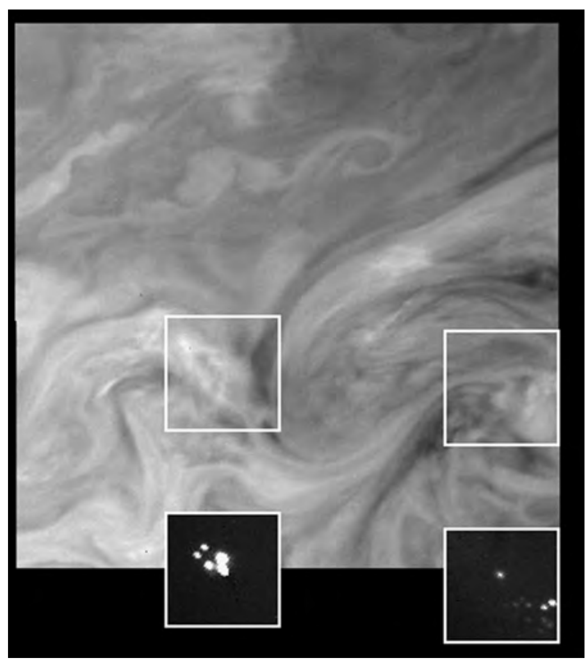
Second Light

Thunderstorms on Jupiter

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

Jupiter has an active atmosphere, with analogues of terrestrial trade winds, cyclones, and anti-cyclones (hurricane-like storms), but until now the energy source driving Jupiter's weather has been poorly understood. The two main possibilities have been Jupiter's internal heat source or sunlight. In the 10 February issue of *Nature*, Peter Gierasch of Cornell University, and Andy Ingersoll of Caltech, along with their groups of collaborators, show that the energy appears to originate from Jupiter's internal heat source, mediated by upwelling regions in its atmosphere that resemble clusters of thunderstorm cells in the Earth's atmosphere.

Even with a small telescope, it is easy to distinguish the banded structure of Jupiter's atmosphere. The dark bands are called belts and the lighter ones zones. Both are interspersed across Jupiter between its equator and mid-latitudes, where the pattern begins to become less regular. Jupiter's "trade winds" blow along the belts and zones at speeds of up to 650 kilometres per hour, which is much faster than the winds on Earth. The latter average about 45 kilometres per hour. When seen up close (from a spacecraft), Jupiter's belts appear relatively chaotic, while the zones are generally smooth. Prior to Gierasch and Ingersoll's work, the zones were believed to result from upwelling gas currents — in effect, it was believed that we were looking at the tops of cloud banks. The belts in this scenario represented regions of



Galileo image of Jupiter, with storm complexes inside the boxes (Credit: NASA/JPL).

downwelling gas currents, which were needed to maintain the overall balance of the atmosphere.

Gierasch has observed, on the basis of data from the *Galileo* spacecraft, that lightning discharges occur in water clouds that lie deep in Jupiter's atmosphere. It appears that the likely explanation for such a phenomenon is to conclude that the thick clouds originate from upwelling gas currents, much like large clusters of thunderstorm cells seen on Earth, particularly in the summer. Anyone who has flown over the south- or mid-western United States in the summer will be very familiar with the huge, mushroom-shaped clouds that contain intense thunderstorms. It turns out that the amount of heat that is carried by the thunderstorm cells on Jupiter is on average approximately equal to the heat flow from the internal energy source of the planet.

The new observations therefore conflict with older ideas about Jupiter's atmosphere. Replacing the concept of dark belts consisting entirely of downwelling gas is a new model in which they also contain a component consisting of upwelling gas currents. Ingersoll has used the available data to argue that the atmospheric gases converge in the belts, with a slight overall upward component. In the new picture, the zones become regions where the net flow of gas is downward, and where the flows of gas tend to diverge.

In the new scenario, gas currents flow downward and outward from Jupiter's zones, then converge at lower atmospheric levels in the planet's belts. The converging flows produce storm clouds, much as on Earth, complete with lightning discharges, but the sizes of the clouds are vastly different. On Earth, large thunderstorm clouds can reach vertical dimensions of up to 15 kilometres (50,000 feet), while the complex that gives rise to them can be as much as a few hundred kilometres in diameter. (Flying around such clouds by jet is quite an interesting experience for terrestrial travellers, if one is not prone to motion sickness.) On Jupiter, however, the cloud complexes can have vertical dimensions of about 50 kilometres and be 4,000 kilometres across. Much as on Earth, the thunderstorm complexes on Jupiter are quite efficient at converting heat from lower atmospheric levels into the kinetic motion of rising gas pockets.

Some early evidence for such an active role by Jupiter's internal heat source for driving its "weather" came from data obtained from the probe on the *Galileo* spacecraft, which entered Jupiter's atmosphere on December 7, 1995 (see the 14 August 1997 issue of *Nature*). The probe indicated that the wind speeds on Jupiter increase with depth in its atmosphere, a feature that is expected if the energy source originates at deep levels, but opposite to what is expected if sunlight powers the meteorology.

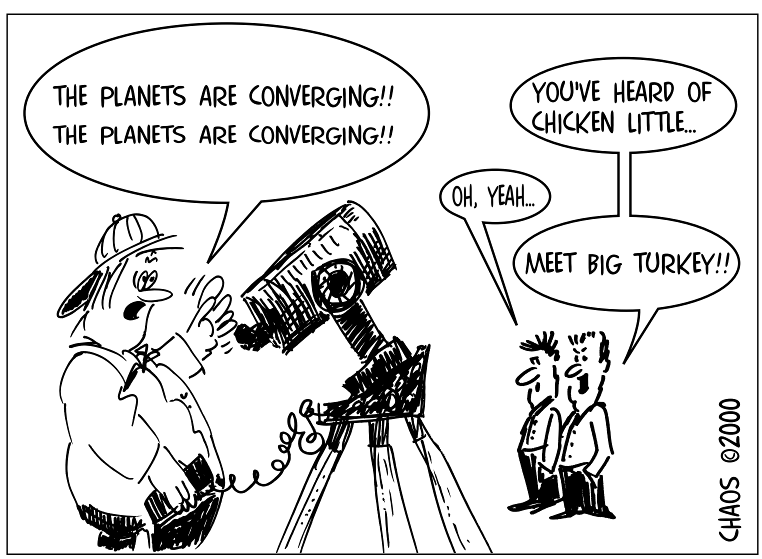
What is the internal source of heat? The consensus right now is that it consists mostly of residual heat from Jupiter's formation. Part of it originates from the gravitational energy released by the planet's gas when Jupiter first accumulated as a protoplanet, and part originates from energy released during the period early in Jupiter's life when the icy-rocky material that formed the nucleus of the accumulating planet melted to form its core. Because Jupiter's surface area is small in proportion to its overall mass, the planet loses energy very slowly — which is still taking place today. That is why Jupiter is considerably warmer than the equilibrium temperature that would be calculated for it solely on the basis of energy supplied by the Sun. (The Earth lost the residual energy from its formation long ago.)

It may come as a surprise to some readers, but we still have no idea why Jupiter's atmosphere is so colourful, or why it has a banded structure. What is clear is that we still have a lot to learn about the planet.

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.*

ANOTHER SIDE OF RELATIVITY

UNCLE ERNIE PANICS AT THE FIRST HINT OF PLANETARY HIJINKS.



STAR PATTERNS ON THE AZTEC CALENDAR STONE

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(Received March 10, 1999; revised December 3, 1999)

Abstract. Presented here are possible identifications for two star-groups that are depicted on the calendar stone of the Aztecs. The first group, which is located at the seven o'clock position on the stone, is strikingly similar to the Milk Dipper in Sagittarius, which is equivalent to the Chinese asterism of Nan-tou, the rice ladle. The second group, which is located at the one o'clock position on the stone, matches the three stars that form the head of Aquila, which is equivalent to the Chinese asterism of Hoku, the herdsboy. The identifications are consistent with the concept of cultural diffusion across the Pacific Ocean in prehistoric times.

Résumé. Nous présentons une identification possible pour deux groupes d'étoiles qui sont inscrits sur le calendrier en pierre des Aztèques. Le premier groupe, que l'on retrouve à la position de sept heures sur la pierre, ressemble de près à la Louche de lait dans Sagittaire, qui correspond aussi à l'astérisme chinois de Nan-tou, la Louche de riz. Le second groupe d'étoiles, paraissant à la position d'une heure sur la pierre, s'accorde avec les trois étoiles formant la tête de l'Aigle et correspond à l'astérisme d'Hoku, le jeune bouvier. Ces comparaisons appuient le concept de la diffusion des cultures d'un côté du Pacifique vers l'autre durant les temps préhistoriques. SEM

1. Introduction

The Aztec calendar stone, or Stone of the Fifth Sun, is a basaltic disk measuring twelve feet in diameter and three feet in thickness, and weighing twenty-four metric tons. It was uncovered in 1790 in Mexico City in what was once the central square of the Aztec capital of Tenochtitlán, and is now on permanent display at the National Museum of Anthropology in Mexico City. The principal feature of the stone is the perfectly circular image that is chock-a-block with mesmerizing Aztec symbols. The hideous monster that stares at you from its centre both repels and fascinates. Its tongue is actually a stone knife, and at either side of the face its claws grasp human hearts. The stone has a religious quality with the ability to shock and attract simultaneously. It was a sacred object in Aztec religious liturgy, and incorporated their astronomy and their worship, as well as their interpretation of past history and their eschatology (doctrine of future events). It is, if one may describe it so, a stone of fiendish holiness or un-holiness, which might explain its mystical quality.

The stone had once been positioned horizontally in a flat stone floor in a sacred location in front of the great temple of Tenochtitlán, and may have been splattered occasionally with the blood of sacrificial human victims in macabre rituals performed by Aztec astronomer-priests. When it was removed from its original setting, the circular disk was preserved intact along with fragmented parts of the floor. What has been preserved is actually egg-shaped and consists of the central circular image plus flanges around it (figure 1). A *National Geographic* article by Molina Montes (1980) includes a spectacular

Fig. 1 — An overview of the 3.6 meter diameter basaltic slab known as the Stone of the Fifth Sun — the Aztec calendar stone — now preserved at the National Museum of Anthropology in Mexico. The patterns of dots chiseled into the edges of the stone may represent constellations in the Aztec cosmos [reproduced with permission from Aveni (1980)].

enhanced image of the stone including the preserved edges. The edges contain dotted patterns, to which Aveni (1980) has called attention because he believes they "may represent constellations" in the Aztec cosmos, although he came to no definite conclusions on their identity.

Perhaps a larger area of the floor was covered with Aztec constellations, so that the complete basalt slab would have given us a detailed insight as to how the Aztecs viewed the heavens. Instead of the entire floor, we have only a few edges around the circular image, and they provide us with a tantalizing glimpse of the Aztec cosmos.

The most obvious feature of the dotted patterns is the simple fact that the Aztecs mapped the heavens by displaying stars as dots or circles, and they formed star-groups by connecting the dots with lines. That means that their constellations were star groups formed by actual stars, and not arbitrary figures inspired by an undisciplined imagination. The dots are therefore real rather than concocted stars, and the stars connected by lines must represent actual stars lying in close proximity to one another in the night sky and clearly visible to the unaided eye.

The practice of connecting-the-dots has been a favourite of sky observers since the science began in Mesopotamia. It is a constant human endeavour in all disciplines to attempt to make sense of apparent randomness. In astronomy the human mind seeks to impose order and recognizable patterns onto the apparent chaos of stellar positions. The ancient Chaldeans and Babylonians in Mesopotamia studied the positions of the stars, imposed patterns on stars lying close together, and composed constellation figures to represent them. Some of their constellation figures bear a resemblance to the suggested star patterns of well-known groups such as Orion and Scorpio, but some do not and seem arbitrary. We have inherited their constellations in the West. They were preserved by Claudius Ptolemy, an Alexandrian astronomer of the second century CE. He "was accustomed to displaying the stars on a globe — yellow dots against a dark background, he tells us in his *Almagest* — with dark lines connecting the stars to remind him of their mythological configurations" [Owen Gingerich, in the foreword to *Uranometria 2000.0* (Tirion *et al.* 1998)]. In any event, the Mesopotamians did not invent or concoct stars, for the dots they connected were actual observed stars, and the patterns were always of stars lying close together in the sky.

The practice of connecting-the-dots was also used in ancient China, where visible stars lying in close proximity were grouped together. "We know from Han carvings and reliefs that the system of representing asterisms by patterns of dots or circles connected by lines goes back at least as far as that period" (Needham 1970). The Chinese connected different stars from those used in the West, however, and that resulted in star groups markedly different from the constellations of the West. That is easily illustrated, for example, using the band of sky covered by the zodiac — the region in which the Sun, Moon, and planets appear to move. In the West the zodiacal band comprises some twelve constellations, but the same area of sky as viewed from China was distributed among no less than 63 star groups.

The difference can also be illustrated by the fact that we now divide the entire sky into 88 constellations, whereas the Chinese had at least 280 star-groups. The Chinese star-groups are consequently of smaller size and of different shape than ours. It raises the gloomy prospect that perhaps the Mesoamericans mapped the heavens in yet a different fashion. But we must keep in mind that the dots or circles on the Aztec stone represent actual stars, each of which must be visible to the unaided eye. In practical terms the brightest stars must figure prominently in Aztec stellar cartography, much as they did in Mesopotamian and Chinese configurations. Such a conclusion is realistic because in all ancient cultures the brightest stars, such as Sirius or the star cluster of the Pleiades, often dominated the astronomy of that era, as well as such practices as calendar making and the worship of a pantheon of stellar deities.

The present paper is an attempt to identify two of the dotted patterns seen at the edges of the Aztec calendar stone in figure 1. The first challenge is the star-group located at the seven o'clock position on the stone. It consists of five tiny circles plus two dots lying closely together, all connected by lines. Those two close dots are an unusual feature of the pattern, and appear to represent two companion stars. A successful identification of the group must explain the pattern and especially the two companions.

The second challenge is the pattern of three circles at the one o'clock position on the stone. They form a straight line. The centre circle is double, however, which emphasizes its greater prominence or brightness. A correct identification of the group should explain the pattern and the special feature of the central star.

2. Aztec Star Group #1

When an attempt was initially made to identify pattern #1, several potential candidates were considered in a process of elimination. Unfortunately, the pattern does not appear to match existing constellations. The four stars seem to form a box or bowl, similar in appearance to the Big Dipper and the Little Dipper, but the latter consist of seven stars clearly spaced apart, a feature that does not conform to the two companion dots in the pattern on the stone. After all potential candidates were exhausted, the problem was put aside while the author learned more about Aztec history and in the process came across Bart McDowell's article on "The Aztecs" (McDowell 1980). An image of the calendar stone is presented in an accompanying article by Molina Montes (1980). At the top of the image of the stone in the twelve o'clock position is a square enclosing thirteen dots and a reed. It represents the year "13 Reed" in the Aztec calendar, equivalent to our year 1011 CE. That date, which represents the commencement of the present age in the Aztec chronology (the creation date for their era), appears to be a potential key to unlocking the constellation challenge. Accordingly, a check was made of Chinese astronomical records of events observed in the same year.

According to Ho (1962), in that same year, 1011 CE, the Chinese recorded a "k'o hsing" or "guest star" which appeared in front of the box of the Nan-tou (the eighth lunar mansion). The date of appearance was equivalent to February 8, 1011 CE, according to Ho (1962). The Chinese asterism Nan-tou is identical to our "Milk Dipper," and consists of the six stars: Mu, Lambda, Phi, Sigma, Tau, and Zeta Sagittarii. Tsi (1955) identifies the same date and star pattern. (Whether the observation had been of a nova or a comet is irrelevant for our present purposes.)

Staal (1988) indicates that the same Chinese star group was also known as Teou-Siou, or the House of the Bushel, which was depicted as a ladle used for measuring rice or meting out rations. Staal's drawing for the group depicts the asterism as a ladle with Mu and Lambda Sagittarii representing the handle, and Phi, Sigma, Tau, and Zeta Sagittarii representing the bowl of the ladle (figure 2).

Allen (1963) reports that Nan-tou was a Chinese ladle or measure, and he quotes from the She-King:

> "In the north is the ladle
> Raising its handle to the West."

Allen (1963) comments further:

> "… that our Milk Dipper (Zeta, Sigma, Phi, and Lambda Sagittarii) in the same spot is not a modern conceit after all. The stars of the ladle were objects of special worship in China for at least a thousand years before our era; indeed, they were also known as a temple."

In modern times the six stars are known as the Milk Dipper, with Mu and Lambda Sagittarii forming the handle and "the bowl consisting of Sigma, Tau, Zeta, and Phi Sagittarii" (Burnham 1978). They are prominent stars in Sagittarius, and they happen to lie in the direction of the densest and brightest section of our Galaxy. They are configured exactly like a dipper to draw milk from the Milky Way. All are stars of second and third magnitude, but they number only six stars, whereas the pattern on the stone contains seven stars.

Although the star Mu Sagittarii at the top of the handle is a telescopic visual double star (Burnham 1978), the small separation of the two stars and the three-magnitude difference in brightness rules out the possibility that the two could be detected with the unaided eye. On the other hand, the fifth magnitude star 15 Sagittarii lies only half a degree away from Mu Sagittarii, and in very nearly the same location as indicated for the companion on the calendar stone. It therefore appears much like a companion star to Mu Sagittarii to the unaided eye. There are therefore seven stars in the Milk Dipper, which actually consists of five stars plus an apparent double. That coincides exactly with the pattern on the Aztec calendar stone. The companion dots, which had presented problems for earlier identifications, are very distinctive. I therefore suggest that the dotted pattern at the seven o'clock position on the Aztec calendar stone represents the stars of our Milk Dipper in Sagittarius (figure 2). Remarkably, the pattern on the stone is also shown as a ladle. The identification of the pattern appears to be beyond doubt.

There is now a remarkable convergence of patterns: the same seven stars of the Milk Dipper in Sagittarius were depicted as a ladle or a dipper by the Chinese, by the Aztecs, and by modern astronomers. The same stars are connected in one group by all three cultures and are pictured in the same way. The only difference is that the Aztec pattern has a distinctive curve in the handle!

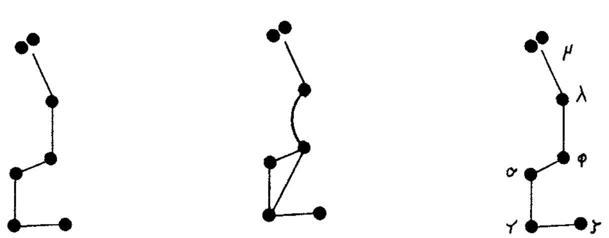

Fig. 2 — Star group #1 at the seven o'clock position on the calendar stone (centre), showing its similarities to the Chinese star group Nan-tou, the ladle or measure (left), and the modern asterism known as the Milk Dipper (right) in Sagittarius.

3. Aztec Star Group #2

As a first step towards identifying the second group of stars, it is useful to consider the angular distances between stars in the Aztec ladle identified above (figure 2). Each of the stars in the ladle is separated from its nearest companion by two or three degrees (Burnham 1978), which provides a sense of scale for the calendar stone. At the same scale the three stars in constellation group #2 lie in a straight line that is about five degrees across. It is also important to note that the central star is by far the brightest of the three. Its symbol is larger than that of the others, including those in the Aztec dipper, therefore it must be brighter than second or third magnitude. The quest thus reduces to a search for three stars that lie in a straight line, about five degrees across, with the central star roughly equidistant from the two outer stars and obviously brighter than the other two to the unaided eye.

The three stars constituting the belt of Orion come to mind, since they are a familiar sight in the night sky. The group satisfies most of the criteria because the three stars are close together in the sky and form a straight line, with the central star equidistant from the outer two. But they fail in other respects since the asterism is only three degrees across and the central star is not obviously brighter than the outer two. The three stars in Orion's belt are all second magnitude stars that appear equally bright to the unaided eye, and they would have appeared similarly bright to Mesoamerican observers. This point seems critical, since the artist who produced the Aztec calendar stone emphasized the prominence of the central star by distinguishing it as a double circle distinct from its companions.

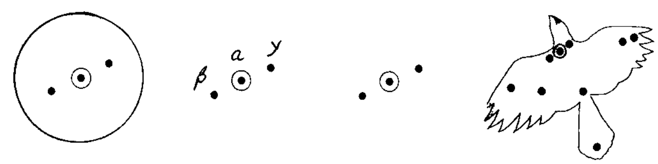

Fig. 3 — Star group #2 at the one o'clock position on the calendar stone (second from left), showing its similarities to the Chinese star group Ho-ku, the herdsboy (left), the Peruvian star group representing three birds of prey (second from right), and the modern constellation of Aquila the Eagle (right).

By contrast, the group of three stars in the head of Aquila — Alshain, Altair, and Tarazed (Beta, Alpha, and Gamma Aquilae, respectively) — lie in a straight line that stretches about five degrees across, with Altair in the centre as a first magnitude star between two fainter stars of third magnitude (figure 3). To the unaided eye of ancient and modern observers, Altair is clearly brighter than the other two. These three stars appear uniquely qualified to conform to the pattern on the stone. It is therefore argued that the three stars on the Aztec calendar stone correspond to the three prominent stars in the head of Aquila.

In China, Beta, Alpha, and Gamma Aquilae form an asterism called Hoku, which is pictured as a herdsboy. Allen (1963) states that the Chinese also pictured the threesome as a drum and placed a circle around them. Staal (1988) notes that in India the three stars were imagined to be footprints of the Hindu god Vishnu, the Preserver of the World, made as he strode across the heavens. In Peru some of the pre-conquest astronomy of the Inca has been preserved in the Huarochiri Manuscript, which was written almost entirely in the Quechua language by an indigenous author between 1598 and 1608 (Bauer & Dearborn 1995). It refers to a certain star group as the "three stars in a straight line" that were individually called Comdormi (a condor), Suyuntuytapas (a vulture), and Guamantapas (a falcon), all birds of prey. It is uncertain whether the term refers to the three stars in Orion's belt or the three stars in the head of Aquila, since either asterism is equally plausible. There is a different Inca reference to a star group called Orcorara, however, which is described as "three stars, all equal." That undoubtedly refers to the stars of Orion's belt, and cannot apply to the three in Aquila. Since Orion's belt was called by the distinctive term Orcorara, it seems likely that the "three stars in a straight line" refers to the three stars in Aquila.

Allen (1963) notes that in Arabia and Turkey the three stars of Aquila formed their own asterism and were pictured as an eagle. In Persia the same group of three was pictured as a falcon. In other words, the same three stars were set apart from other stars in several cultures that include those of China, India, Mesoamerica, Peru, Arabia, Turkey, and Persia. In contrast, our modern constellation of Aquila is somewhat out of step, since we combine Beta, Alpha, and Gamma Aquilae with six nearby stars — a total of nine stars — to form an eagle in flight on a much larger celestial canvas (figure 3).

4. Discussion

The remaining dots along the left edge of the calendar stone are only fragments of Aztec star groups, since the stone is broken off at this edge. One is left to ponder if the lower curved row of dots (figure 1) represents the constellation of Capricorn, or if the uppermost diamond of four dots represents Aquarius, including Alpha Aquarii. Only speculation is possible, since there is very little in the dotted patterns to distinguish them. The present identification of the other two star groups avoids speculation, however, and is based upon valid historical and rational analyses. The other dotted patterns seem like so many stars bunched together with few distinguishing features, as though they were of secondary importance to whoever planned the layout of the stone. That suggests that the principal purpose of the dotted patterns was to depict two star groups of pre-eminent importance to the Aztec astronomers. Extra care was taken to portray them carefully with regard to relative brightness and spacing. The star patterns are also displayed with distinctive features, which permits us to eliminate potential candidates in turn until only one finalist remains in each case: the Milk Dipper in Sagittarius and the three prominent stars in the head of Aquila.

The first star group is the Milk Dipper in Sagittarius, and it is spread partly above but mostly below the ecliptic. It is interesting that Aveni (1980) discusses "the case for a Zodiac" in Mesoamerica, and presents paintings from an old manuscript and a door lintel at Chichen Itza. Each displays a row of animals graphically described by Aveni as "hanging with clamped jaws from Sun symbols below a continuous band." He recognizes the Sun symbols and continuous band as the ecliptic, and speculates that the parade of animals represents the zodiacal constellations in Mesoamerican cartography. They include a rattlesnake, a tortoise, a scorpion, a pair of birds, a vulture, a serpent, and possibly others. Since the ecliptic cuts across the Milk Dipper in Sagittarius, that star group gives the impression of "hanging" from the ecliptic and is a likely candidate for one of the Aztec zodiacal constellations. Perhaps it was also pictured as a bird or animal. If this star group is typical of the other Aztec asterisms, then one can speculate that the Aztec zodiac consisted of a band of constellations partly above and mostly below the ecliptic. It would have consisted of a set of asterisms, just a few degrees in width (in comparison with our modern constellations, some of which span 18° of sky), each straddling the solar path, in all likelihood numbering more than 12 in total. Since the Aztec star groups were much smaller than our Western constellations, they would have formed a sky band much narrower than our present-day zodiac.

5. Conclusions

The present investigation of the dotted patterns on the Aztec calendar stone tells us something about the history and practice of astronomy. The custom of forming star groups by "connecting the dots" appears to have been a universal pursuit. It was no different in Mesoamerica than in Mesopotamia, or in China, or the Land of the Inca, or in modern astronomy. While there are some differences in the final results, there are also remarkable similarities. In many ways, the constellation identifications support the concept of cultural diffusion across the Pacific Ocean. In much the same manner as the steep-sided pyramids of Central America resemble those of southeast Asia, and notably some members of the Angkor Wat complex, the constellation figures apparent on the Aztec calendar stone are consistent with a common cultural thread that links the inhabitants of both Central and South America with those of Asia and Asia Minor. Stars were represented by dots, and they were grouped together by "connecting the dots." Although theoretically there seems to be no limit to how stars can be grouped together, in practice astronomers in ancient and modern times often seem to have connected the same stars in similar fashion, as well as to have used everyday objects — such as a ladle or animals — to map the heavens.

As argued here, the Aztec calendar stone, in addition to all its other layers of fascinating information, seems to be a permanent record of an independent observation of an unusual star that was recorded by the Chinese in 1011 CE, with the same year and sky position chiseled on basalt. That discovery was an accidental byproduct of the present investigation, and it opens up a different line of investigation beyond the scope of this paper. Although the image dominating the centre of the Aztec calendar stone is still repulsive, one cannot help but admire the ingenuity of the Aztec astronomer-priests for packaging so much information onto one slab. They emblazoned the highlights of their astronomy and religion and cosmology in symbols on this basaltic slab. And it was done without a single word of explanation on the stone — an achievement without parallel.

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ROBERT S. McIVOR is an insurance investigator from central British Columbia who holds a Fellowship degree from the Insurance Institute of Canada, as well as a degree in theology from the University of London. Born in the north of Ireland, he immigrated to Canada in 1968. His academic interests include astronomy and chronology, and numismatics, the former spurred by college courses he has taken. All three interests are combined in his long-held fascination with the events surrounding the Star of Bethlehem, which resulted in his recent publication of a book on the subject: Star of Bethlehem, Star of Messiah *(Overland Press 1998). As indicated by the present study, he is also interested in the astronomy of Central America.*

FROM THE PAST AU FIL DES ANS

THE DIFFUSION-OF-CULTURE CONTROVERSY — UNITY OF MAYA AND CHINESE ASTRONOMY DECIDES IT

On this subject three papers have been presented to the Royal Society of Canada: two by myself and one, prepared at my request, by Professor Kiang. My apology for this fourth paper is based on the fact that new astronomical material of a precise character has appeared, the mathematical nature of which seems decisive. In my second paper I mentioned the studies of the astronomer Robert Henseling, a notable scientific author who was director of the city planetariums of Stuttgart and Berlin. Some months ago I received from him his article "The Scope and Antiquity of Mayan Astronomy," now published in English. Being convinced of the great value of his studies, I wish to direct attention to his epochal achievement, of which my opinion is stated in the title of this communication. My previous view was that the decision of the diffusion-of-culture controversy would probably resemble that in the evolution controversy, to wit, by the accumulation of an overwhelming body of converging proofs. His mathematical demonstration is an unexpected performance and it was a joy to point out to this modest scholar the unique nature of his feat. In doing so, I make no claim to be a final authority, being merely accustomed to the value of evidence, and having acquaintance with North American Indians, and certain general historical aspects of archaeology.

In 1935 Herr Henseling, having become interested in the possible relation of Maya and Chinese astronomy, visited the Maya country with several fellow astronomers, in order to study the stelæ and other monumental records on the spot. He was particularly struck with the early stelæ at the old City of Naranjo, in Yucatan. Returning, he completed his studies, whereby he discovered a striking convergence of many unusual astronomical events establishing that the "commencing date" (zero-date) of the Maya chronology (similar to the year 1 A.D.) was a year of wonders celestial so memorable as to establish a natural starting-point for reckoning of time. It also practically coincides with the Chinese starting-point. In his article mentioned above, adopting the correlation of H. Spinden, who fixes the commencing-date as B.C. 3373, Henseling explains the coincidences in question in these words:

> However divergent the views of researchers into the ancient civilization of the Mayas may be, in one respect they are united. All agree that regarding the motions in time of the heavenly bodies, the Maya priest-astronomers were very much better informed than those of any other old civilization, especially as to the methods of correcting errors of neglect of day-fractions of periods by insertion or omission of whole-day time values. As they had no instruments for precise measurement of angle and time, their exactitude depended on, firstly, a very long and faithful handing down of simple yet exact observations, and, secondly, a reliable system of time-reckoning, astronomically oriented and checked. How excellently they could bridge even millennia and severe vicissitudes has not yet been adequately realized. I shall illustrate by an example certain findings supporting my hypothesis that their astronomy was based on a tradition several, nay many thousands of years old. My investigations are based on facts ascertained from the astronomical relations of constellations for groups of dates and single dates from inscriptions and codices, especially those found by Ludendorff, Spinden and Morley and computations and studies of my own, based on Spinden's correct correlation. In fixing the correction of periods, the Mayas had a predilection for a system of reckonings of high perfection. For the tropical year (from spring equinox to spring equinox) this period-correction is effected thus: Reckoning in movable 365-day solar years, they found that after 104 such years an intercalation of 25 days was necessary. They thus achieved a somewhat better value than that of the Julian equation. Their final value was however another, statable as

follows: 'When 1508 round-years of 365 days have elapsed, then exactly 1507 tropical years have been accomplished.' This coincides exactly with the most precise valuation of the tropical year computable by modern methods, and is therefore superior even to the equation employed in the Gregorian calendar. In their preference for this mode of representing period-values, they referred back to the constellation of the Sun and planets on the zero-day of the Maya time-reckoning. They were the first to employ that most abstract and simple of chronological processes, *viz.* counting the days from a once-and-for-all clearly settled point of the absolute lapse of time. We must suppose that the constellation of the heavens at the zero-epoch must have been handed down from generation to generation of the Maya priests as a most sacred possession. Within historical times the Mayas refer back to a zero-day in the autumn of –3373, expressly designated in several inscriptions as the day of fulfilment of 13 major periods of 144,000 days each. Thus they knew the answer better than we.

He illustrates this from three important stelæ dated A.D. 540, 530 and 521, at their ancient city of Naranjo, and compares the positions of Saturn, Jupiter and Mercury in relation to the Sun on the various dates of these stelæ.

It will be seen that on the main date, which tropically fairly closely agrees with the zero-date, the three planets, at the equivalent synodic phase of revolution, are also very approximately in the same relative positions to the Sun as on the zero-date, and for Saturn and Jupiter the same applies also in the case of both of the other Naranjo dates. Jupiter throughout is not far from opposition, Saturn three times near conjunction and once near opposition… *If all this is a sheer chance, it is a very strange one, for recurrences of constellations of such a nature are extremely rare.*

He illustrates by the longitudes west of the Sun, of Saturn, Mercury and Jupiter, on zero-day and the three dates of the stelæ, and follows with a sketch of their striking conjunctions and oppositions. He then shows that they accurately include also the subtle difference made by the precession of the equinoxes.

What is decisive is the fact that similar examples to the one deduced are to be met at every step… Every one of their temple sites… possessed an artistic presentation of the entire science of astronomical period-reckoning at their command.

Incidentally he also places a point on his sketch indicating the southern intersection of the Milky Way and the ecliptic midway between Mu and Lambda Sagittarii. "It is the *zero-point for measurements in the ecliptic, dominating, without our knowing why, in ancient Chinese astronomy.* Here we can understand the reason: On zero-day the Sun and Saturn stood at this point in the heavens." *Henseling thus shows the original unity of the Maya system with the Chinese, and by so doing he mathematically decides the famous diffusion-of-culture controversy* in favour of those who class the Maya with the original archaic civilization.

Besides the date B.C. 3373, he remarks that they also distinguished an earlier date still, as the beginning of a previous period, to wit, a day in the summer of B.C. 8498, doubtless not exact mathematically but of great traditional value as "the oldest date of human traditional history."

May I venture to compare the date B.C. 3373 to the beginning period of Egyptian history, the epoch of the First Dynasty, somewhere around B.C.. 3400; and that of B.C. 8498 to some of the recent estimates of the beginnings of the archaic civilization, and perhaps to still more recent estimates that might be safely conjectured for the rise of agriculture, and with them the beginnings of astronomy, the handmaid of agriculture — both certainly worth attempts at chronological speculation.

Dr. William Bell Dawson, son of Sir William Dawson, in an article entitled "The Cycle of Jupiter and Saturn" in this *Journal* for May-June 1921, discussing the interesting conjunction of these two planets of September 1921, fixed the beginning of this cycle in B.C.. 3382 — only nine years before 3373 — and notes its occurrence at the primary point in the zodiac, thus connecting that date "with the first devising of the signs of the zodiac." Unwittingly he thus corroborates R. Henseling's calculation and contributes to the settlement of the diffusion-of-culture controversy.

by W. D. Lighthall,
from *Journal*, Vol. 33, pp. 1–4, January, 1939.

Society News/Nouvelles de la société

We have all celebrated with the world the beginning of the last year of the century, and have turned another page in the history books. Let us spend a few moments on what the RASC has been doing in recent months. If any Centre or individual has anything that they would like to share with the rest of the Society, please forward a message to the National Secretary at kimhay@kingston.net.

NATIONAL OFFICE

Bonnie Bird and Isaac McGillis have made it through another Christmas rush, and are working hard on fulfilling everyone's recent orders and membership renewals. If you have any questions or concerns, please contact Bonnie at rasc@rasc.ca or Isaac at member@rasc.ca.

THE MILLENIUM GENERAL ASSEMBLY

With the arrival of summer comes the time for the annual General Assembly (GA). When the nights shorten and reduce the time we have available for viewing the stars, dedicated and novice members of the RASC take the opportunity of the GA to celebrate their experiences in astronomy with their national colleagues. This year the Millennium General Assembly (or "GA 2K" for short) is being held in Winnipeg, with interesting speakers, lots of astronomy, good friends, and the kind of exuberant celebration for which westerners like to claim ownership. Registration will begin on Friday, June 29th, and the proceedings will wrap up on Sunday, July 2nd.

Winnipeg has lined up three dynamite speakers for the Assembly, led by Dr. Wendy Freedman, one of the three co-leaders of the *Hubble Space Telescope* Key Project. Recently featured in *Astronomy* magazine, Dr. Freedman's interests lie at the beginning of things — the age and evolution of the universe. Those beautiful images from the *Hubble Space Telescope* showing distant galaxies, Cepheid variables, and the transient glow of supernovae are all part of her search for the beginning of it all.

Steve Edberg and Don Parker are well-known names in the amateur and professional community. Both appear frequently in the pages of *Sky and Telescope* and *Astronomy*, Don for his spectacular high-resolution images of the planets, and Steve for his equipment reviews and observing tips. In his day job, Steve works for the Jet Propulsion Laboratory in Pasadena, where he helps manage the *Cassini* probe that is now on its way to Saturn. Don is the consummate planetary observer, and his first love is Mars. His work has found a place in professional journals as well as in the pages of amateur publications.

The GA will be held at the University of Manitoba, with accommodation available on campus at St. John's College for a very reasonable fee. The meeting is a family affair, and tours and trips to many of Manitoba's summer events have been arranged. There are boat trips down the Red River to the old Hudson Bay Company fort, fireworks at the Forks "Winnipeg's heart" on Canada Day, and visits to the zoo, Fort Whyte Nature Centre, the Red River Exhibition, the Manitoba Museum, and the Planetarium. Winnipeg also provides a gateway to the spectacular beaches of Lake Manitoba and to Riding Mountain National Park.

Information and a registration package can be found at the GA 2000 web site (www.rasc.ca/ga2000/), by contacting Stan Runge at stan.runge@mts.mb.ca, or by sending a note to Stan Runge, GA 2000, 35 Cunard Place, Winnipeg, MB, R3T 5M1. Information on poster and paper presentations can also be found in the same places. A limited number of registration packages are also available through Centre representatives.

THE PROPOSED FEE INCREASE — WHY?

As you may have heard by the time you read this, the Society's National Council unanimously approved an increase to the Society's fees at its meeting held on March 18th in Toronto. The motion followed extensive study and a detailed report by the Finance Committee, and was accompanied by a lengthy discussion about many aspects of the RASC's finances. Under the RASC's by-laws, fees are set by the membership. As a result, the recommendation by Council for an increase in fees will come before the membership for approval at the Annual Meeting to be held on July 3, 2000 at the General Assembly in Winnipeg. The proposed increase is from $36 to $40 per year for ordinary members, from $22.50 to $25 per year for youth members, and from $720 to $800 for life membership fee.

Why has National Council approved the fee increase, and why is it asking you to approve it? There are several ways of examining the issue. Let us first remind ourselves that the last fee increase took place in 1993, when fees were set at $36 per year for ordinary members and $22.50 for youth members. The life membership fee ($720) was set at a multiple of 20 times the annual fee for ordinary members. Individuals may pay more if they belong to one of the Centres that has a surcharge. Since the last fee increase, the Consumer Price Index has risen by about nine percent, and the resulting general increase in the cost of goods and services is reflected in increased costs for the Society. Printing, mailing, labour costs — all of them have gradually risen over the years, while fees have remained constant.

Of more importance, in the last several years additional services and benefits have been added to the RASC's membership package. The *Journal* has been revitalized and is now a larger format, expanded, and more readable publication. Council has added, at no additional charge to the membership, six issues of *SkyNews* annually. The cost of *SkyNews* for individual subscribers is about $24 per year, whereas the Society provides that publication to members at a reduced rate. In addition, a smoothly running membership handling system has been instituted, with two full-time employees at National Office who serve the Centres and the membership, and respond quickly to problems and queries. It should surprise no one that all such initiatives have cost money — a great deal of money. In short, the membership has asked for and is now receiving services and benefits at a much higher level than in the past, and the Society has to ensure that it can continue to pay for those benefits and services.

It may surprise you, and it has concerned Council greatly, that the marginal cost of servicing a new member actually *exceeds* the fee revenue that a new member generates, by a substantial amount. For example, every new member receives (i) the *Observer's Handbook*, (ii) six issues of *SkyNews* per year, (iii) a copy of the *Annual Report*, (iv) membership handling services, mailing and database maintenance, and (v) six issues of the *Journal*. The total retail value of the above goods and services is well over $100, yet through the efforts of its unpaid volunteers, the Society manages to keep the marginal cost of servicing a new member to about $23.35 (with actual costs expected to increase). By contrast, the membership fee revenue to the Society of $21.60 for an ordinary member and $13.50 for a youth member represents an average revenue of only $21.10 per member. The resulting imbalance between revenues and expenses is particularly serious because the Society's membership is increasing very quickly, at a current rate of about 15 percent per year. The ironic result is that, as time goes on and more and more members join the Society, it will lose more and more money! It is time to ensure that new members at least pay for the services provided to them, and the proposed fee increase will just barely do that.

In 1999, for the first time in several years, the Society sustained a deficit, and will do so again in 2000. To pay for two years of deficits, it is necessary for the Society to divert more than $50,000 from its investments to use for current operations. That in turn reduces its investment income.

Council has concluded that the Society probably went too long without a fee increase, and absolutely must begin to restore a proper balance to the Society's finances. If membership fees are not increased, and other ways to augment revenues are explored, the only alternatives available are continued erosion of the Society's asset base or a reduction in benefits and services. Neither alternative is attractive. It is for that, and other reasons, that Council has proposed what it considers to be a very modest fee increase. If you wish to safeguard your Society's assets, and maintain the benefits and services that all members now enjoy, please vote in favour of the fee increase. Even if you do not plan to attend the Annual Meeting in July, you can still help. This issue of the *Journal* contains a notice of the Annual Meeting along with a form of proxy in which you have the opportunity to cast your vote. Please take the time to complete and mail in your proxy on this important issue.

Michael Watson, National Treasurer

SUMMER STAR PARTIES

Last fall in the Society News, there was an insert on summer star parties. The time is nearly here to think about summer observing plans. The National Secretary would like to include any star parties that were not listed last fall. If you wish to announce such an event, please send notice to kimhay@kingston.net or to Kim Hay, R.R. #2, Perth Road, Ontario, K0H 2L0, so they can include them in a forthcoming Society News.

NATIONAL YOUTH GROUP

As most people realize, young children constitute what will become the next generation of scientists and researchers. Part of the RASC's mission statement involves education in astronomy and science, and that includes children as well as older members. Education in astronomy may begin even with something as simple as becoming involved in observing the wonders of the night sky. In order to promote our mission to today's youth, the RASC's National Website (http://www.rasc.ca) now contains a Youth Page that we hope will bring young astronomers together. The page was created by Brendon Roy (Thunder Bay), and has links to other astronomical websites. It provides youngsters who have interests in astronomy with a focal point for their interests, and a place where they can get together for a chat if they wish. We hope that all youngsters (we are all young at heart) will visit the page and contact Brendon if they have any ideas or interests that they would like to see there. You can contact Brendon at vcarson@foxnet.net.

RECOVERING…

Leo Enright (Kingston) is well on his way to a fast recovery from his heart surgery of last fall, and Heinz Berrys (Unattached) is recovering from his recent heart problems as well. Our wishes for speedy recoveries go out to both long-time members of the RASC.

CONGRATULATIONS TO…

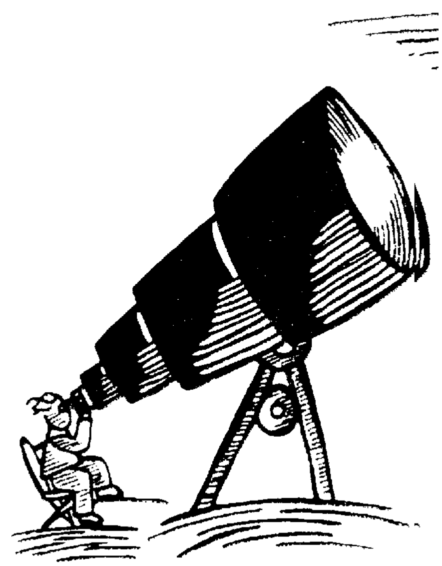
At the fall meeting of National Council held on October 23rd 1999, several award nominations for the Messier Certificate were passed by Council. The recipients of Messier Certificates are: Alexander Dutkewych (Unattached Member), Geoff Gaherty (Toronto Centre), Johanne Gamache (Montreal Centre), Guy Mackie (Okanagan Centre), Ron. C. Scherer (Okanagan Centre), and Jan Wisniewski (Victoria Centre).

Now that the month of March is past, how many of you were successful in your Messier Marathons? March has traditionally been the best month to make a one-night attempt at the Messier Certificate, since it is possible to observe all 110 objects of the RASC Messier list on one good clear night. Perhaps those Centres or individual observers who had successful Messier Marathons will be evident through applications for the RASC's prestigious Messier certificates.

Special congratulations are in order for Alexander Dutkewych (Unattached Member), who was also approved for the presentation of the Finest NGC Certificate by National Council.

Congratulations to all award winners, and may the same enthusiasm rekindle our love of astronomy.

Ask Gazer



Dear Gazer,

I read with fascination your column regarding the almost continuous clear skies in the vicinity of Dr. Roy Bishop's world-famous Maktomkus Observatory in Avonport, Nova Scotia (August 1999, JRASC, 93, No. 4, pg. 196). It is most gratifying to finally have the answer, plus the observational evidence to support your theory, as to the reason why he enjoys more clear, photometric quality, skies than any other observer in Canada. Bravo!

You seem, however, to have omitted one critical aspect to the entire issue. That is to say, the Black Umbrella Method, or B.U.M. I have personally witnessed this seemingly miraculous phenomenon, whereby Dr. Bishop produces the aforementioned Black Umbrella, shakes it ferociously at the heavens, and lo — the clouds part and clear skies prevail!

To further complicate matters, Dr. Bishop claims not to have taken the Black Umbrella along on his most recent eclipse expedition of August 11, 1999, when meteorological experts all agreed that the chances of clear skies over the North Atlantic Ocean were abysmal at best — and just when one would think that the device would be most desperately needed. Large, ground-based, microwave transmitters notwithstanding, how do you account for the B.U.M. and the apparent lack of the B.U.M. for Dr. Bishop's successful eclipse cruise this past summer?

Please do give us the rest of the story! Partial explanations are so very frustrating, don't you agree?

Mystified Member from Middle Musquodoboit

Dear Mystified:

I have also heard of this alternate method that Dr. Bishop uses for dispersing clouds. Without investigating it firsthand, I find it difficult to say how the method might work. It is curious to note that he has to open the umbrella, allowing for the possibility that a parabolic wire mesh is concealed inside. It may be possible to concentrate the microwave energy from the Avonport transmitters into a tight beam, and transmit it to the umbrella, using the dish in the umbrella to beam the microwaves back into space. If that is the case, I think it would be easy to check. Simply determine if he is wearing an anti-radiation suit under his regular clothes! Another test would be to scatter microwave popcorn around him to see if it undergoes spontaneous popping.

With regard to the eclipse cruise, there is a very simple explanation. Given enough time, events will occur in which random elements tend to work in one person's favour — he got lucky!

Gazer is a member of the Halifax Centre who wishes to remain anonymous. Gazer's true identity is known only to past editors of Nova Notes, *the Halifax Centre's newsletter. Questions to Gazer should be sent to gazer@rasc.ca.*

The Complete All Splendors, No Fuzzies Observing List

by Alan Whitman, Okanagan Centre (awhitman@vip.net)

FALL OBJECTS (31):

[I have never resolved Theta or p Eridani. I have never seen the four objects in Tucana: GC NGC 104, Beta Tuc, the SMC, and GC NGC 362.]

ID	Con	Type	RA(2000)	Dec(2000)	Mag.	Size	Remarks
NGC 7009	Agr	PN	21:04.2	−11:22	8.3	0′.5	Saturn Neb [Lord Rosse]; greenish; 24-in: ansae
61	Cyg	Dbl	21:06.9	38:45	5.2,6.1	28″	Orange dwarfs
M15	Peg	GC	21:30.0	12:10	6.4	12′	Core peaks like Mt. Fuji; CC IV
M2	Aqr	GC	21:33.5	−00:49	6.5	13′	Brightest CC II
Zeta	Aqr	Dbl	22:28.8	−00:01	4.4,4.6	1″.9	Both white
NGC 7293	Aqr	PN	22:29.6	−20:48	6.5	13′	7×50s show Helix Nebula; annular
NGC 7662	And	PN	23:25.9	42:33	9.2	0′.3	Blue Snowball [Copeland]; 10-in: annular
NGC 7789	Cas	OC	23:57.0	56:44	6.7	16′	Ri, 300 faint st
NGC 55	Scl	G-Sc	00:14.9	−39:11	8p	25′×3′	4-in: diffuse splinter
NGC 104	Tuc	GC	00:24.1	−72:05	4.0	31′	NE; 47 Tuc: 2nd best GC; CC III
Beta	Tuc	Dbl	00:31.5	−62:57	4.4,4.5	27″	Both blue-white
M31	And	G-Sb	00:42.7	41:16	3.5	160′×40′	NE; 8-in: 2 dl, st cloud, GC G1
M32	And	G-E2	00:42.7	40:52	8.2	3′	M31 group; also M110, NGC 147, NGC 185
NGC 253	Scl	G-Sc	00:47.6	−25:17	7.1	22′×6′	Elongated, mottled; GC NGC 288 adj
SMC	Tuc	G-Im	00:52.6	−72:48	2.8p	216′	NE; Cl, EN inv
NGC 281	Cas	EN	00:52.8	56:37	7p	35′	Use UHC; DN inv
NGC 362	Tuc	GC	01:03.2	−70:51	6.6	13′	Milky Way GC beside SMC; CC III
NGC 457	Cas	OC	01:19.1	58:20	6.4	13′	Kachina Doll Cluster: splendid
M33	Tri	G-Sc	01:33.9	30:39	5.7	60′×40′	Difficult NE; 8-in: spiral arms; 16-in: six N inv; 24-in: four arms
p	Eri	Dbl	01:39.8	−56:12	5.8,5.8	12″	Both yellow-orange dwarfs
NGC 663	Cas	OC	01:46.0	61:15	7.1	16′	80 st; four OC within 2°
Gamma	Ari	Dbl	01:53.5	19:18	4.8,4.8	7″.5	Both white
Gamma	And	Mlt	02:03.9	42:20	2.1,4.8	9″.6	Gold, blue; C m 6.0, BC 0.″5
Iota	Tri	Dbl	02:12.4	30:18	5.2,6.6	4″.0	Gold, blue
NGC 869,884	Per	OC	02:19.0	57:09	4.4	30′,30′	NE; Double Cluster; 350 st
Omicron	Cet	Var	02:19.4	−03:00			Mira:orange, watch m rise with NE
NGC 891	And	G-Sb	02:22.6	42:21	10.0	14′×3′	Edge-on; 16-in shows dl
M34	Per	OC	02:42.0	42:47	5.2	35′	NE; fine in small scopes
Theta	Eri	Dbl	02:58.2	−40:19	3.4,4.4	8″	Both white
Beta	Per	Var	03:08.2	40:57			Algol: NE eclipsing binary
Alpha	Per	OC	03:22.0	48:36	2.3	240′	Alpha Per Assoc: use binoculars

WINTER OBJECTS (34):

[I have never observed f Eridani.]

ID	Con	Type	RA(2000)	Dec(2000)	Mag.	Size	Remarks
Pleiades	Tau	OC	3:47.0	24:07	1.2	120´	=M45; NE; Merope RN is L-shaped
f	Eri	Dbl	3:48.6	−37:37	4.9,5.4	8″	Yellowish st
32	Eri	Dbl	3:54.3	−02:57	4.5,6.1	7″	Topaz, greenish
Hyades	Tau	OC	4:20	15:38	0.8p	400´	NE; very large, V-shaped
NGC 1851	Col	GC	5:14.1	−40:03	7.3	11´	CC II
h3752	Lep	Dbl	5:21.8	−24:46	5.4,6.6	3″.5	Gold, blue; GC M79 36´ ENE
LMC	Dor	G-SBm	5:23.6	−69:45	0.6p	432´	NE; many EN and Cl inv
M38	Aur	OC	5:28.7	35:50	6.4?	21´	Difficult NE; OC 1907 and NE OC M36 adj
M1	Tau	SNR	5:34.5	22:01	8.4	6´	Crab Nebula [Lord Rosse]
M42/43	Ori	EN	5:35.4	−05:27	4	66´	Orion Neb NE; Trapezium Mlt inv; greenish-gray; 16-in: reddish-brown areas; DN inv; RN 1973+ adj
NGC 2070	Dor	EN/OC	5:38.6	−69:05	8.2	40´	NE; Tarantula Neb in LMC
Sigma	Ori	Mlt	5:38.7	−02:36	3.7	—	Bluish; eight st
NGC 2024	Ori	EN	5:41.9	−01:51	—	30´	Flame Neb; with branching dl
M37	Aur	OC	5:52.4	32:33	5.6	24´	Difficult NE; Ri: 150 st
M35	Gem	OC	6:08.9	24:20	5.1	28´	NE; Ri; OC 2158 and IC 2157 adj
8	Mon	Dbl	6:23.8	04:36	4.4,6.7	13″	Yellow, bluish
Beta	Mon	Mlt	6:28.8	−07:02	4.7,5.2	7″	C mag 6.1 at 2.″8; three blue-white st
NGC 2237	Mon	EN	6:32.3	05:03	—	80´×60´	Rosette Neb; UHC reveals DN inv; NE OC 2244 inv
M41	CMa	OC	6:47.0	−20:44	4.5	38´	NE
M50	Mon	OC	7:03.2	−08:20	5.9	16´	
NGC 2392	Gem	PN	7:29.2	20:55	8.3	0´.2	Clown-Face Neb [Burnham]; blue-green
Alpha	Gem	Mlt	7:34.6	31:53	2.0,2.9	3″.9	Castor: white, blue-white; C mag 9.1 at 73″
k	Pup	Dbl	7:38.8	−26:48	4.5,4.8	10″	Both white
M46	Pup	OC	7:41.8	−14:49	6.1	27´	Ri M46 has PN 2438; NE OC M47 adj
M93	Pup	OC	7:44.6	−23:52	6.2	22´	
NGC 2451	Pup	OC	7:45.4	−37:58	2.8	45´	Orange c Pup inv
NGC 2477	Pup	OC	7:52.3	−38:33	5.8	27´	300 mag 12 st
NGC 2516	Car	OC	7:58.3	−60:52	3.8	30´	NE
Zeta	Cnc	Mlt	8:12.2	17:39	5.6,6.0	5″.8	Three yellow st; B mag 6.0 at 0.8″
M44	Cnc	OC	8:40.1	19:59	3.1	95´	NE; Beehive Cluster; many Mlt
IC 2391	Vel	OC	8:40.2	−53:04	2.5	50´	NE; bright st
IC 2395	Vel	OC	8:41.1	−48:12	4.6	8´	
Iota	Cnc	Dbl	8:46.7	28:46	4.0,6.6	30″	Yellow, blue
M67	Cnc	OC	8:50.4	11:49	6.9	18´	

SPRING OBJECTS (40):

[I have never resolved Alpha Crucis. I have never seen the Carina GC NGC 2808, the Vela PN NGC 3132, or the Vela GC NGC 3201.]

ID	Con	Type	RA(2000)	Dec(2000)	Mag.	Size	Remarks
NGC 2808	Car	GC	9:12.0	−64:52	6.3	14´	Brightest CC I
NGC 2903	Leo	G-Sb	9:32.2	21:30	8.9	11´×5´	
M81	UMa	G-Sb	9:55.6	69:04	6.9	16´×10´	6×30 finder shows M81, M82
M82	UMa	G-I	9:55.8	69:41	8.4	7´×2´	13-in: mottled, two diagonal dl
NGC 3132	Vel	PN	10:07.0	−40:26	8p	0´.8	Eight-Burst Neb; easy mag 10 cn*

NGC 3201	Vel	GC	10:17.6	−46:25	6.8	18′	CC X
Gamma	Leo	Dbl	10:20.0	19:50	2.6,3.8	4″.4	Gold, yellow-green
NGC 3242	Hya	PN	10:24.8	−18:38	8.6	0′.3	Ghost of Jupiter; pale blue
IC 2602	Car	OC	10:43.2	−64:24	1.9	50′	NE; Theta Car Cl; 5° S Eta Car
NGC 3372	Car	EN	10:43.8	−59:52	3	120′	NE; Eta Car Neb; chevron dl
NGC 3532	Car	OC	11:06.4	−58:40	3.0	55′	NE; 3° ENE Eta Car; Ri, oblate
M97	UMa	PN	11:14.8	55:01	11.2?	3′.2	Owl Neb [Lord Rosse]; "eyes" with 6-in, OIII; G-Sc M108 adj
Xi	UMa	Dbl	11:18.2	31:32	4.3,4.8	1″.8	Yellow pair
M66	Leo	G-Sb	11:20.2	12:59	9.0	8′×3′	Trio with M65, NGC 3628; 16-in: two arms in M66 and 3628's dl
NGC 3766	Cen	OC	11:36.1	−61:37	5.3	12′	Five OC within 4°
M106	CVn	G-Sb	12:19.0	47:18	8.3	20′×6′	
Coma Ber	Com	OC	12:25.1	26:06	2.9p	300′	NE; very large
M86, *etc.*	Vir	G-E3	12:26.2	12:57	9.2	7′	Heart of Virgo Cl: ten Gs in 1° field
Alpha	Cru	Dbl	12:26.6	−63:06	0.8,1.2	4″.0	Blue-white pair
24	Com	Dbl	12:35.1	18:23	5.0,6.6	20″	Deep yellow, blue-white
NGC 4565	Com	G-Sb	12:36.3	25:59	9.6	16′×3′	Remarkable edge-on; thin dl
M104	Vir	G-Sb	12:40.0	−11:37	8.3	7′×2′	Edge-on Sombrero Galaxy with dl
Gamma	Vir	Dbl	12:41.7	−01:27	3.4,3.5	1″.5	Both pale yellow; closest in 2007
NGC 4631	CVn	G-Sc	12:42.1	32:32	9.3	15′×3′	Humpback Whale Galaxy [Hewitt-White]; 4656/7 adj
M94	CVn	G-Sb	12:50.9	41:07	8.2	11′	Defies moonlight (show on Astronomy Day)
Coalsack	Cru	DN	12:51	−63:00	—	360′	NE; OC 4755 (Jewel Box) adj
M64	Com	G-Sb	12:56.7	21:41	8.5	8′×4′	Black-eye Galaxy [W. Herschel]; dl
M63	CVn	G-Sb	13:15.8	42:02	8.6	8′×3′	Sunflower G; 7×50s reveal it
Zeta	UMa	Dbl	13:23.9	54:58	2.3,3.9	14″	Mizar: bluish-white, greenish-white; Alcor adj
NGC 5128	Cen	G-S0	13:25.5	−43:01	7.0	10′×3′	Cen A; dl from merging spiral
NGC 5139	Cen	GC	13:26.8	−47:29	3.7	36′	NE; Omega Cen: best GC; CC VIII
M51	CVn	G-Sc	13:29.9	47:12	8.4	11′	Whirlpool Galaxy [Lord Rosse];8-in: spiral arms; 5195 inv
M83	Hya	G-SBc	13:37.0	−29:52	7.6	11′	8-in: bar; 13-in: spiral arms
M3	CVn	GC	13:42.2	28:23	6.4	16′	CC VI
M101	UMa	G-SC	14:03.2	54:21	7.7	27′	Numerous brighter knots
Alpha	Cen	Dbl	14:39.7	−60:49	0.0,1.3	21″	Yellow pair; closest NE star
Epsilon	Boo	Dbl	14:44.9	27:05	2.7,5.1	2″.8	Izar; deep yellow, blue
NGC 5907	Dra	G-Sb	15:15.9	56:19	10.4	12′×2′	Edge-on Splinter Galaxy
M5	Ser	GC	15:18.6	02:05	5.8	17′	CC V
Zeta	CrB	Dbl	15:39.4	36:38	5.1,6.0	6″.3	Blue, greenish

SUMMER OBJECTS (53):

[I have never seen the Pavo GC NGC 6752.]

ID	Con	Type	RA(2000)	Dec(2000)	Mag.	Size	Remarks
NGC 6025	TrA	OC	16:03.7	−60:30	5.1	12′	
Beta	Sco	Dbl	16:05.4	−19:48	2.8,4.9	14″	White, pale blue
M4	Sco	GC	16:23.6	−26:32	5.9	26′	Central bar of st; CC IX
Rho	Oph	Mlt	16:25.6	−23:27	5.2,5.9	3″.1	Both bluish; two wide mag 7 companions
Alpha	Sco	Dbl	16:29.4	−26:26	1.0,5.4	2″.9	Antares; beautiful orange, emerald; requires very steady seeing
M13	Her	GC	16:41.7	36:28	5.9	17′	NE; star chains at margins; CC V

M12	Oph	GC	16:47.2	−01:57	6.6	15′	CC IX
NGC 6231	Sco	OC	16:54.0	−41:48	2.6	15′	NE; False Comet [Whitman]: with Zeta (nucleus), 6231 (coma), OC H12 (tail)
M10	Oph	GC	16:57.1	−04:06	6.6	15′	Pair with M12 3° NW; CC VII
M62	Oph	GC	17:01.2	−30:07	6.6	14′	CC IV
M19	Oph	GC	17:02.6	−26:16	7.2	14′	CC VIII; oblate
Alpha	Her	Dbl	17:14.6	14:23	3.5v,5.4	4″.7	Orange, blue-green
36	Oph	Dbl	17:15.3	−26:36	5.3,5.3	4″.6	Orange twins
M92	Her	GC	17:17.1	43:08	6.5	11′	8-in: bulging rectangle; CC IV
Pipe Neb	Oph	DN	17:21	−27	—	7° long	NE; B59, B65, B66, B67, B78
Rho	Her	Dbl	17:23.7	37:09	4.6,5.6	4″.1	Both white
Nu	Dra	Dbl	17:32.2	55:10	4.9,4.9	62″	Both white
M6	Sco	OC	17:40.1	−32:13	4.2	15′	NE; Butterfly Cluster [Burnham]; four OC adj
NGC 6397	Ara	GC	17:40.7	−53:40	5.7	26′	Easily resolved, st m 10; CC IX
IC 4665	Oph	OC	17:46.3	05:43	4.2	41′	NE
M7	Sco	OC	17:53.9	−34:49	3.3	80′	NE; fine in binoculars
M23	Sgr	OC	17:56.8	−19:01	5.5	27′	NE; Star cloud M24 and OC M25 to east
NGC 6543	Dra	PN	17:58.6	66:38	8.8	0′.3	Cat's Eye Neb; 8-in: oval, cn*
40−41	Dra	Dbl	18:00.2	80:00	5.7,6.0	19″	Yellow st
95	Her	Dbl	18:01.5	21:36	4.9,5.1	6″	Silver, gold
M20	Sgr	E/RN	18:02.3	−23:02	6.3	29′	Trifid Neb [J. Herschel] with FOUR dl; OC M21 adj
B86	Sgr	DN	18:03.0	−27:53	—	4.5′×3′	OC 6520 adj
M8	Sgr	EN	18:03.8	−24:23	5.8	90′	NE; dl; OC inv
70	Oph	Dbl	18:05.5	02:30	4.0,6.0	3″.7	Yellow, orange
NGC 6541	CrA	GC	18:08.0	−43:42	6.6	13′	CC III
B92	Sgr	DN	18:15.5	−18:14	—	15′×10′	In spectacular star cloud M24; B93 adj
M16	Ser	EN/OC	18:18.8	−13:47	6.0	35′	Eagle Neb; UHC; DN inv: The Star-Queen Nebula [Burnham]
M17	Sgr	EN/OC	18:20.8	−16:11	6.0	46′	Swan Neb [Burnham?]; DN inv
M28	Sgr	GC	18:24.5	−24:52	6.9	11′	CC IV
M22	Sgr	GC	18:36.4	−23:54	5.1	24′	Oblate CC VII; 3-in resolves
Epsilon	Lyr	Mlt	18:44.3	39:40	5.0,6.1 5.2,5.5	2″.6 2″.3	The Double-double: four white st
M11	Scu	OC	18:51.1	−06:16	5.8	14′	Dense; 200 st m 11; DN adj
M57	Lyr	PN	18:53.6	33:02	9.0	1.3′×1′	Ring Nebula [W. Herschel]; cn* with 16-in at 400×
OΣ525	Lyr	Dbl	18:54.9	33:58	6.0,7.7	45″	Albireo-like
M54	Sgr	GC	18:55.1	−30:29	7.7	9′	CC III; part of Sgr Dwarf G, 16-in resolves extragalactic stars!
NGC 6723	Sgr	GC	18:59.6	−36:38	7.3	11′	CC VII; near Gamma CrA
NGC 6752	Pav	GC	19:10.9	−59:59	5.4	20′	CC VI
Beta	Cyg	Dbl	19:30.7	27:58	3.1,5.1	35″	Albireo; yellow, blue
M55	Sgr	GC	19:40.0	−30:58	7.0	19′	Brightest CC XI
B142/43	Aql	DN	19:41	11	—	80′×50′	Difficult NE; fine in binoculars
NGC 6826	Cyg	PN	19:44.8	50:31	9.8	0′.5	Blinking Planetary [Mullaney/McCall]; cn* m 10
M27	Vul	PN	19:59.6	22:43	8.1	7′	Dumbbell Nebula [J. Herschel]
NGC 6940	Vul	OC	20:34.6	28:18	6.3	31′	Ri
NGC 6960	Cyg	SNR	20:45.7	30:43	—	70′×6′	Veil Neb; OIII; longer Nile-like nebulosity adj for many fields
Gamma	Del	Dbl	20:46.7	16:07	4.3,5.1	10″	Yellow, pale green
NGC 6992/5	Cyg	SNR	20:56.4	31:43	—	78′×8′	Veil Neb; OIII; 6992 in 7×50s
NGC 7000	Cyg	EN	20:58.8	44:20	—	120′	NE; North America Neb [Wolf]; DN inv; UHC
Funnel Cloud	—	DN	21:00	55:00	—	12° long	NE Funnel Cloud Nebula [Whitman] cuts almost across the Cep/Cyg Milky Way

Abbreviations used:

A = component A of a double or multiple star
adj = adjacent
B = component B of a double or multiple star
B = (with number) Barnard's catalogue of dark nebula
C = component C of a multiple star
CC = concentration class for globular clusters, from I to XII
Cl = cluster(s)
cn* = central star of planetary nebula
Dbl = double star
dl = dark lane in galaxy or emission nebula
DN = dark nebula
EN = emission nebula
G = galaxy (with type)
GC = globular cluster
IC = Index Catalogue
-in = inch (as in "8-in," meaning a telescope of 8-inch aperture)
inv = involved
LMC = Large Magellanic Cloud
M = Messier Catalogue
m, mag = visual magnitude
Mlt = multiple star
[name] = the originator of a descriptive name
NE = visible with the naked eye
Neb = nebula
NGC = New General Catalogue
OC = open cluster
OIII = An Oxygen III nebular filter ([O III]) is recommended
p = photographic magnitude
PN = planetary nebula
Ri = rich in stars
RN = reflection nebula
SMC = Small Magellanic Cloud
SNR = Supernova remnant
st = star(s)
UHC = A filter passing both [O III] and Hydrogen Beta is recommended
Var = Variable Star
? = the author questions the *NGC2000.0* visual magnitude

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Most deep-sky data are from *NGC 2000.0*. For the few facts not available from *NGC 2000.0*, the following *Observer's Handbook* 1999 lists were used in this order of preference: *Galaxies: Brightest and Nearest* by B. Madore (for the dimensions of elongated galaxies and for LMC and SMC data), *The Messier Catalogue* and *The Finest N.G.C. Objects* by A. Dyer, *Nebulae* by W. Herbst, and *Star Clusters* by A. F. J. Moffat.

Double star co-ordinates, magnitudes, and separations are from the *Observer's Handbook* 1999, when available. Guide 7.0 software by Project Pluto was used for the remaining doubles.

Retired weatherman Alan Whitman is now a full-time amateur astronomer. His other interests include windsurfing on the Okanagan Valley's lakes, hiking and skiing on its mountains, and travel. He invites observing reports for use in this column from experienced amateurs who have largely completed their Messier list.

The History of Astronomy

Myths and Legends

by Barbara Silverman, Montreal Centre

Over the years countless myths and legends have been told and retold about the sky above us. They have become an integral part of the cultural heritage of the many civilizations that, down through the ages, have inhabited our Earth. Handed down by word-of-mouth around ancient campfires, the stories helped to explain the mysterious ever-changing skies, bringing order and stability to the lives of those dwelling beneath them.

I have chosen stories representing various people from different lands with different lifestyles, but with one common element — survival. That required understanding what was around them, including the night sky. So pull up a chair, forget the computer and telephone, and picture a campfire and a group of people warming themselves under a canopy of twinkling starlight, accompanied by the voices of the elders as they tell their tales.

India — The Story of the Pole Star

Our first stop is the mystical land of India. Dhruva, the son of a king, and his mother Sunite, fell victim to the jealousy of the king's second wife. Banished from the palace, Sunite took her infant son and went to live outside the kingdom in a small cottage at the edge of a large forest. Nine seasons came and went. Dhruva began to wonder about his father. Finally the boy decided it was time for the two of them to meet.

He traveled to the palace and was amazed by its splendour: white marble statues, floors of coloured stone, and fountains in open courtyards. His father was overjoyed to see him, welcoming the young man with open arms, but that was not the case with the king's second wife. The king, in order to save his son's life, was forced to send the boy away again.

Confused and hurt, Dhruva returned home. His father was the king, but he was weak and helpless. Surely, he thought, there must be someone all-powerful. To his question his mother replied, "That is Lotus-eyes, a god not of earth but who dwells in the heart of the forest."

That night Dhruva set out in search of Lotus-eyes. For days he walked through dense, dark forest. First, he encountered a tiger, then a large black bear. Those two mighty denizens of the forest walked away with lowered heads after being asked by the boy, "Are you Lotus-eyes?" Finally, he reached a clearing in the heart of the forest. There he met Norada, the forest sage and one of the seven wise men of India who live in the seven stars of Ursa Major.

As happened with the tiger and bear, the lad received a negative reply to his question, but the old sage instructed Dhruva to pray until all thoughts disappeared except those of whom he sought. So pray he did, even to this day. Years passed while the white ants built the world of stars around him. He continued to pray even when the truth came to him that Lotus-eyes existed only in his own heart.

Today we still see the young prince, oblivious to the circling universe, lost in prayer and meditation. He shines with a steady immobile light as the heavens revolve around him. No longer is the light referred to as Dhurva Lok, the place of Dhurva. Over the centuries, it has become known to us as the Pole Star.

> **"I have chosen stories representing various people from different lands with different lifestyles, but with one common element — survival."**

Mexico — The Origin of the Pleiades

Hun-Apu and Xbalanque were heavenly twins engaged in a longstanding feud with a primeval giant known as Zipacana (similar to the Greek Titans in strength and unruly disposition). The twins decided that the time had arrived to be rid of Zipacana for good. They gathered several youths who were willing to aid in the plot.

Pretending to build a house, the group of youths dug a huge hole. Zipacana, curious as to what the boys were up to, went to investigate. When told by the youths that his help was needed to dig the hole deeper, Zipacana jumped in and began digging. Immediately the boys filled the hole with stones, earth, tree trunks, and anything else that would serve their purpose. Then they continued to build a house over the grave — but Zipacana was not dead. For a long time he lay still, regaining his strength, recovering from the shock, and waiting.

After the house was finally completed, all the architects gathered to celebrate their success in disposing of the giant. It was then that Zipacana exploded from under the foundation. With his great strength, he threw the house and its builders so hard that they were sent to the region of the stars. There the conspirators huddled together, unable to get back down to the earth. Even after others were eventually successful in disposing of the giant, the youths remained in the heavens to become the asterism we now call the Pleiades.

Polynesia and North America — The Rainbow

Have you ever gazed in wonder at a rainbow, thinking how marvelous nature must be to create such beauty? We now have the scientific explanation, but that was not the case for our ancestors. How would they explain such a phenomenon? Let us stop first at Atiu, one of the southernmost of the Cook Islands in the South Pacific, to hear the Polynesian legend of the Rainbow Bridge.

Ina was a moon goddess who fell in love with, and married, a mortal. For many, long happy years the couple lived together on the Moon. Then, as with all that is mortal, the man grew old. Ina, knowing that her husband was nearing the end of his days, grieved. Not only was she losing the man she loved, but she would also be unable to be with him as his time ended. On the Moon there is no place for death, therefore the old man had to return to Earth to finish his life. Ina, desiring to make his trip back to the Earth as easy as possible, designed the rainbow to form a bridge between the Moon and the Earth. Thus, the old man was able to travel in comfort. To this day, after the rain has fallen and the Sun once again shines, we are able to see the symbol of the goddess's love for a mortal.

Closer to home, the Wyandot Indians of North America also have a story explaining how the rainbow bridge came to exist. In the beginning the first animals were very comfortable here on Earth. Then a fight broke out between Ice-and-stone and his brother Fire. Ice-and-stone introduced the long cold death of winter to the world. Fire fought back with Thunder, helping him. Then Summer arrived, armed with lightning. Rainbow joined the battle, restoring warmth, light, and colour.

The first animals rejoiced but remained uneasy. What if Winter wanted a rematch? Deer greatly feared the return of bad weather. He convinced Rainbow to carry him to the safety of the sky. The rest of the animals joined Deer by marching over Rainbow into the heavens. To ensure their safety, the bridge behind them was burned to ash, spreading over the skies as the Milky Way. That is why Rainbow is only a faint image of the original, and can be seen weeping in a summer rain just as the Sun once again shines.

Greece — Gemini

Looking up into the night sky from November to June, we see the constellation of Gemini. Here we find the brightest, closest pair of stars seen from the northern hemisphere. Many cultures have grouped the two stars together. The Greeks called them the Dioscuri or Zeus's sons. The Romans called them the Twin Brethren. The Persians referred to them as Du Paikar (Two Figures). To the Egyptians they were Horus the Elder and Younger. And the Phoenicians called them Two Kids or the Two Gazelles.

The Greek and Roman legends are very similar, and it is from them that the stars received the names by which they are known to this day — Castor and Pollux (short for Polydeuces), the heavenly twins.

The twins were the sons of Leda, who was the wife of Tyndarus, King of Sparta. One day Zeus (Jupiter to the Romans) approached Leda in the form of a swan. The boys, Castor and Pollux, were the result of that union. While both are referred to as the Dioscuri, only Pollux was immortal. Castor was not; it is possible that he may have been the son of Tyndarus.

Castor and Pollux were inseparable, and renowned for their athletic ability, Castor in horsemanship and Pollux in boxing and fighting skills. Both married daughters of a Spartan king. They joined Jason on his quest for the Golden Fleece, and it was on that voyage that Castor and Pollux gained their reputation as the patron saints of sailors and adventurous people.

One day when they were far from land, a terrifying storm developed. As the sailors prayed for their lives, Orpheus played his harp, asking the gods to spare the ship. The storm ended as suddenly as it had begun. Lights suddenly appeared over the heads of Castor and Pollux (probably St. Elmo's Fire). The two lights or stars were given the names of the twins, and the boys received credit for saving the ship. To this day it is the custom, especially of sailors, to pray to Castor and Pollux when in danger. Their heliacal rising is said to coincide with the calm seas of summer, and they have become the sailor's favourite talisman.

Eventually Castor was killed during a battle. Being mortal, he was destined for Hades or the Underworld as his final resting-place. Hades was not considered a place of punishment, but one of constant and everlasting dullness. Pollux wanted to join his brother, and he rejected his immortality, but that still meant that upon his death he would be sent to Mount Olympus, the home of the gods. He pleaded with his father, Zeus, to allow him to join Castor in the underworld on his death. Zeus was unable to grant Pollux his wish, but did arrange a compromise. They could remain together, but would have to divide their time between Hades and the Heavens. Half of the day was to be spent in the underworld, the other half above. Later, to commemorate their fraternal loyalty, Zeus gave them a place in the constellation Gemini, and to this day the stars Castor and Pollux mark the heads of the twins.

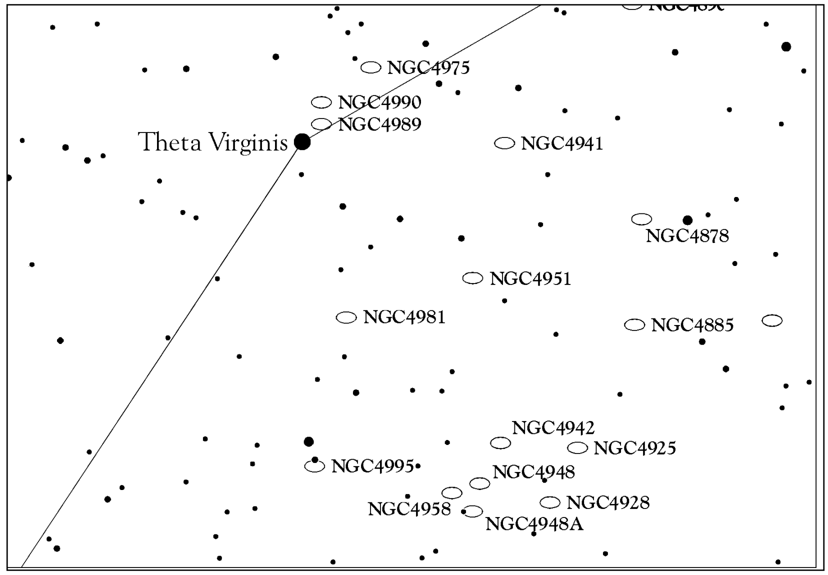
According to the legend, it is not unusual for the twins to leave their place in the skies to ride with the mortals. In 484 BCE, Castor and Pollux became the patron deities of Rome when they came to the aid of the Romans. During the Battle of Lake Regillus, the Etruscans fled upon seeing the two white-clad immortal horsemen riding alongside the Romans The twins then rode back to Rome, washed their horses in a well, and then rode to the door of Vesta's temple and disappeared. Upon the site of the well, Aulus Postumius built a temple honouring the brothers.

To this day, statues still stand showing them on their horses with a star shining over each of their heads. Their likeness appeared on the earliest silver coins of Rome, and July 15th, the day of the battle, was kept sacred. The greatest honour for their loyalty to each other, however, is the two shining stars up in the heavens for all to see.

Barbara Silverman recently retired from a career as a junior accountant. She has had a life-long fascination with astronomy, but is relatively new to the RASC. Having joined the Montreal Centre only a few years ago, she is already a member of the Centre's Board of Directors. Her main interest in astronomy is its history, including archeoastronomy. Her other main hobby is science fiction, and she is currently working on a novel in that genre.

Scenic Vistas: North of Spica

by Mark Bratton, Montreal Centre (mbratton@generation.net)



A 4-degree high field in Virgo showing stars to about 9th magnitude (ECU Chart by Dave Lane).

The month of May is probably my favourite observing month of the year. After a bitter winter and an often-unsettled early spring, the temperate evenings of May offer a window of opportunity that no observer should miss. The nights are still relatively long, though the rapid approach of summer quickly shrinks the number of dark hours. The evenings remain cool enough so that the mosquitoes, which are starting to become prevalent during the day, usually disappear shortly after sunset. May is the perfect time to explore the galaxy-speckled regions north of Spica, an area of the sky that is well placed for observing for only a few short weeks. There is much to explore here and it cannot be accomplished in one short season, or even a few. You will find that once you visit this part of the sky, you will return at least once every year of your observing career.

A good place to start is by aiming your telescope at fourth magnitude Theta Virginis, just north and west of Spica. Immediately north and west of Theta Virginis, and in the same field, lie two faint galaxies, NGC 4989 and NGC 4990. It is best to use the highest magnification available to observe these objects since the light from Theta Virginis easily overpowers them. Fortunately, though, both small galaxies have a relatively high surface brightness. NGC 4989 is brighter overall than its companion by almost a full magnitude, an oval glow with a faint stellar core oriented north-northwest to south-southeast. NGC 4990 is a very small, almost stellar, patch a little brighter to the middle with a faint nucleus intermittently visible.

Nudging your telescope just a little further north and west brings you to NGC 4975, though you will need a fairly large aperture to have any hope of success. The *Deep Sky Field Guide to Uranometria 2000.0* lists the galaxy at magnitude 14.7, and I found it very faint, a little larger than NGC 4990 but very poorly defined with a diffuse envelope not much brighter than the sky background. The glow seemed a little more concentrated towards the middle.

Not all is faint in this region, however, and four galaxies located south and east of Theta Virginis all shine at magnitude 11, easily visible in an 8-inch telescope, and not even much of a challenge for a 6-inch. NGC 4941 lies 1.5 degrees due west of Theta Virginis. A fairly bright galaxy, it is highly-elongated almost north-south. The galaxy features a much brighter, round and detached core with a faint stellar nucleus visible at high magnification. Though the galaxy is bright, the outer envelope is diffuse and poorly defined. A field star of magnitude 11 lies about three arcminutes to the south.

NGC 4951 can be found about one degree south-southeast of NGC 4941. A prominent oval object that is oriented exactly east-west, it appears a little brighter to the middle but lacks a stellar nucleus. The main envelope is fairly well condensed, but the edges are diffuse. Another degree east-southeast of NGC 4951 we come to the bright spiral NGC 4981. It is a very bright galaxy located north-northwest of a magnitude 10 field star, the separation is about 30 arcseconds. The envelope of the galaxy is oval and fairly bright, but the edges are quite diffuse. The core is sizeable and quite bright, but a stellar nucleus was not visible.

NGC 4995 is located about four arcminutes south-southeast of a magnitude 8 field star. The oval envelope is oriented exactly east-west with fairly well-defined edges, and the core is a little brighter to the middle.

All seven galaxies are located within two degrees of Theta Virginis and can be easily observed in one evening. The area north of Spica is a vast area covering hundreds of square degrees and scores of galaxies. You can explore a different section, as I do, each and every May.

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.

Reviews of Publications
Critiques d'ouvrages

Observing Variable Stars: A Guide for the Beginner, by David H. Levy, pages 198 + xix, 25 cm × 17.5 cm, Cambridge University Press, 1998, Second Edition. Price US$18.95, paperback. (ISBN 0–521–62755–9)

According to the information provided on page iv, this book is the first paperback edition of a 1989 hardcover volume of the same title published by David Levy. The added statement "with corrections" implies that it has also been modified in order to remove typographical errors found in the original. Indeed, the list of acknowledgements which thanks various individuals for proofreading the original text reads much like a who's who of popular astronomy, which makes it all the more difficult to understand why the book still contains many fundamental errors. According to my reading, another iteration is sorely needed in order to transform the book into the effective introduction to variable star observing that it purports to be.

Observing Variable Stars is intended for novice amateur observers who are interested in delving into the field of variable star observing. Although aimed primarily at those equipped with telescopes of small to moderate aperture, the book also provides an introduction to variable star observing for those who do not possess their own telescope or who only observe using binoculars. A vast selection of potential target stars are identified and described, each listed with specific observing instructions and a number from one to five related to its degree of difficulty. For some stars there are short background notes related to individual peculiarities or their manner of discovery. I found them to be a marvelous method by which novices could obtain useful information on specific target objects as well as the motivation to observe the stars for themselves. They are something that is often missing in other introductions to the subject.

Also included are anecdotal accounts that have been culled from the author's personal observing logs. In that sense the book provides insights into David Levy's own love for the observational side of astronomy, and the possible rewards associated with glimpses of the specific targets identified in the book. One cannot help but be inspired by the sheer depth of variable star observing accumulated by the author. The book is clearly written by someone who is demonstrably a master of the art.

Although the book's 33 chapters give the initial impression of a monograph laid out in formidable detail, most of them are short and they are arranged conveniently into only four primary sections: an introduction to the sky and observing techniques, a summary of the main types of variable stars that can be observed using simple eye estimates, a detailed listing of specific objects that are within reach of most telescopes (arranged according to season), and a miscellany that includes detailed historical notes on early enthusiasts as well as additional notes of interest to the potential specialist. The book is also complemented by numerous star charts, some taken directly from the American Association of Variable Star Observers (AAVSO), that act as guides to finding specific variables by their location relative to named stars in specific constellations. Light curves are included for a select sample of stars. Examples are provided of the light curves for most common types of large-amplitude variables. Once again they are taken from the AAVSO archives of published work. I was a bit disappointed by that, and would have preferred to have seen some of the author's own light curves incorporated into the text. The verbal descriptions he provides for the various stars would be that much more effective if the author could have included some light curves in which his own observations are obvious. Most variable star enthusiasts are keen to see how closely their observations track the recorded light variations of their target stars.

The strength of the book lies in the fact that it is intended for amateur sky observers and is written by someone very accomplished in the field — David Levy. In pleasant contrast to many of the books written by professional astronomers, *Observing Variable Stars* is easy to follow and interesting to read, and lacks most (but not all!) of those annoying syntax errors that seem so commonplace in today's scientific writing. The frequent use of personification for adjectives related to stars and constellations also gives them a pleasant, familiar feel. The author is clearly at home with his celestial surroundings, and wants readers to feel that same sense of intimacy when they use the book as an introduction to the art of visual variable star observing.

The timing of the book may or may not be ideal. Its appearance on the market occurred just prior to the availability of the *Hands-On Astrophysics* material from the AAVSO, which includes a lengthy and more detailed guide to the observation of variable stars. In some ways *Observing Variable Stars* is outclassed by the latter, yet in a few respects it also seems superior. I thought that the inclusion of specially-constructed diagrams, which outline the main constellation figures while at the same time identifying the location of bright variables, was a great improvement on the standard AAVSO variable star charts, many of which are also incorporated. AAVSO charts tend to be oriented to telescope observers who are equipped with proper telescope setting circles, and it is a nice change to be able to locate specific variables relative to named stars that are in the same field. The added star charts therefore make a nice touch to this volume (but see comments below).

While the writing style of *Observing Variable Stars* is generally friendly and light, there are occasional glitches that should have been caught in the proofreading process. I read over the third sentence on page 79 several times, for example, before I realized that the word "with" was missing. Section 22.4 on observing comets progresses through a discussion of how to estimate the brightness of a comet by comparing its in-focus image to the out-of-focus images of stars of known magnitude, then suddenly digresses to how the collision of Comet Shoemaker-Levy 9 with Jupiter in 1994 produced dark spots on the latter. The connection is fleeting at best. Although a variety of other such glitches can be found in the text, generally they have been kept to a minimum.

I found the occasional phrase describing objects of personal interest for my own research to be somewhat amusing. U Sagittarii is noted, for example, to be "a rare example of a Cepheid variable in an open star cluster (M25)." In fact, there are now about 30 good cases to be found in the sample of Milky Way Cepheids that are bright enough to observe with small telescopes. Likewise, P Cygni is included as a potential target for summer observing, despite the fact that this luminous blue variable is a challenge even for photoelectric observers.

Essential for any beginning book on variable star observing is a description of the mechanisms that produce light variability in each type of object. It is here that the weaknesses of *Observing Variable Stars* become more apparent. When the author discusses his personal experiences observing the stars mentioned in this book, he is safely in his own element. That is not the case when he describes the aspects of stellar evolution associated with the mechanisms inducing light variability, or even when relating stellar trivia. In describing the variability of Cepheids, for example, he states that "all the hydrogen has been transformed to helium, and in that outer layer, helium becomes ionized." This is a gross misrepresentation of the actual situation, in which hydrogen has been depleted in the cores of the stars but is present in its original abundance in the stellar envelopes where pulsation occurs. Indeed, hydrogen ionization in the envelope is a very important component of the pulsational destabilization. There are a few other such blunders, but the essential point is that there should be none at all for a book of its intended purpose.

An example of misused trivia can be found in the section on Betelgeuse. On page 62 Levy mentions how Betelgeuse was resolved by Michelson and Pease in 1922 using interferometry, from which an angular diameter of 0.04 arcsecond was obtained. The next sentence states that "more recent attempts using a variety of techniques yield a diameter of one and a half *billion* kilometers." Actually the more recent attempts simply yield the angular diameter of Betelgeuse with greater precision. In order to obtain the actual size of the star, in kilometers or whatever, one must incorporate a reliable distance estimate. The latter is a parameter that is probably much better known now than previously thanks to the *Hipparcos* mission, but there is still quite a bit of uncertainty in the actual value as a result of the large distance of Betelgeuse from the Sun. Two pages earlier the author makes note of the correct pronunciation of the star's name from the original Arabic as "bet' el jews," but translates that as "armpit of the Central One." A more literal translation of the abbreviated Arabic is simply "of the giant," without reference to location. Betelgeuse more correctly marks the shoulder of Orion, not his armpit.

Another weakness lies in the added star charts, which appear to have been taken from a photographic atlas of the sky but without attribution. Lines have been added to trace the familiar constellation outlines, and Greek letter designations have been added for the brighter stars. The quality of the added diagrams is very uneven, however, and the artist who added the Greek letters occasionally misrepresented the letters of the Greek alphabet! In the chart (Fig. 6.1) for Delta Cephei, for example, the two close stars to the Cepheid are identified incorrectly as Epsilon (ϵ) and Xi (ξ). Their proper designations are Epsilon (ϵ) and Zeta (ζ). The two stars *are* correctly identified later in Fig. 28.6, however. Reference to the text is of little help, since they are described there as Epsilon and Zeta, without any direct connection to the actual Greek symbols. Novice observers unfamiliar with the Greek alphabet or with detailed star charts will likely experience some difficulty in associating the text with the book's charts. Even I had trouble. Reference to the Greek alphabet included as section 33.2 in the book is only of marginal assistance, since the symbols there have also been garbled (the symbol for Tau is incorrect, for example)!

Similar errors arise in a number of the other charts, where the nomenclature is sloppy or the chart and the accompanying text do not appear to coincide. Fig. 28.8 of Andromeda, for instance, contains a cross denoting the location of R Andromedae, the first-named star in Andromeda, but the letter "R" was omitted, leaving the cross as a mystery for the reader. Close examination of the other added charts reveals similar typographical errors or omissions, which are far too commonplace in a revised edition of a text. There should have been much greater care paid to details of this type.

Although the strength of the text lies in the author's familiarity with the techniques he is describing, there are still a number of areas where he could have done better. The use of CCD detectors for variable star observing is barely mentioned, for example, even though there are lots of variable star observers who have become adept at making magnitude estimates right off the computer screen. At the 1997 fall meeting of the AAVSO in Chicopee, Massachusetts, Ron Zissell gave a personal demonstration of the technique at the Mount Holyoke College Observatory. Likewise, Levy mentions on page 37 that differences in brightness of about 0.1 magnitude are possible to detect in visual observing as long as one is within about two magnitudes of the visual limit. In my experience that may be a bit optimistic. My own estimates become rapidly less accurate once the stars are about a magnitude brighter than the visual limit.

For that matter, very little is said about "naked eye" observing, even though the text does discuss how to observe stars like Delta Cephei, Eta Aquilae, and Betelgeuse using only visual comparisons with nearby reference stars. That works well for Delta Cephei, where the variable and nearby reference stars are close enough that they all fall on the eye's fovea. It becomes a bit more challenging for Eta Aquilae, since the comparison stars are more distant from the variable. That makes it necessary to use rapid changes in sight line to determine the brightness of the variable relative to the standards, a technique that can produce less reliable estimates. For a bright star like Betelgeuse, the reference stars are so distant from the variable itself that eye estimates of its brightness must be a particular challenge. Regrettably, such difficulties are not addressed in the text.

Several classes of variable star are not mentioned in the text at all, but that is understandable given that most of them undergo such small light variations that they would be impossible to detect visually. The small-amplitude Delta Scuti stars are one such example. The author also fails to identify properly the subtle differences that separate one class of variable star from another. What he refers to as "Cepheids," for example, turn out to be a mix of classical Cepheids, RR Lyrae variables, and Type II Cepheids, the latter of which include W Virginis stars as well as BL Herculis objects. And BB Herculis variables have become a separate class in recent years, distinct from other types of long-period variables.

All in all, *Observing Variable Stars* fills an important niche in its attempt to entice amateur astronomers to the joys of variable star observing. Most of what it attempts to do it accomplishes reasonably well. Novice observers would probably find a more advanced level book like *Variable Stars* (Hoffmeister, Richter, and Wenzel, Springer-Verlag, 1985), for example, to be much too detailed and without much in the way of practical advice. By contrast, most introductory sky guides lack specifics about the how and where of variable star observing. Unless the avid amateur is keen enough to obtain information about variable star observing directly from the AAVSO, which is a reasonable alternative, then *Observing Variable Stars* is a good place to start. The main point is this, however. As David Levy himself points out, you cannot expect to enjoy the marvels that come from variable star observing unless you actually give it a try!

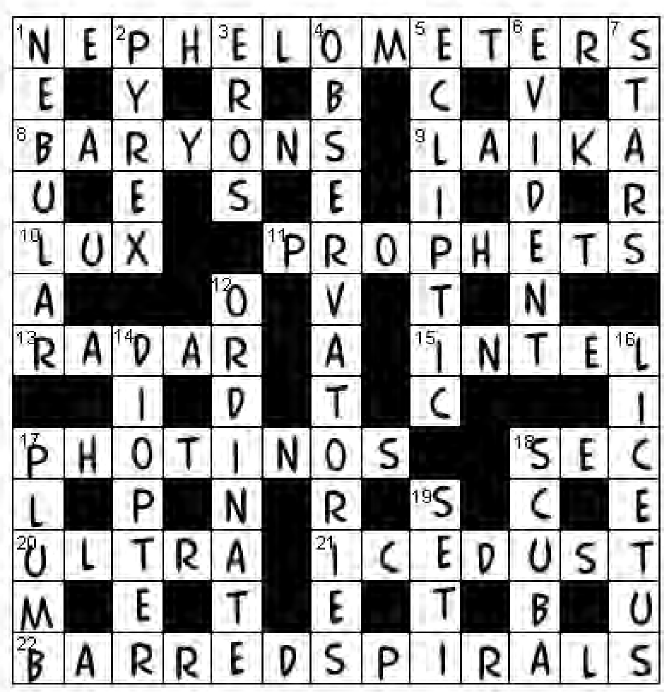
David G. Turner

David Turner is the editor of the Journal, *and is involved in the study of variable stars at the professional level. Most of his observations of Cepheid variables have been done by means of photoelectric photometry and CCD imaging, but he has also made eye estimates for bright variables from his backyard.*

Astrocryptic

by Curt Nason, Halifax Centre

Here are the answers to last issue's clues:



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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 1999 edition received two awards from the Ontario Printing and Imaging Association, Best Calendar and the Award of Excellence. (designed and produced by Rajiv Gupta).

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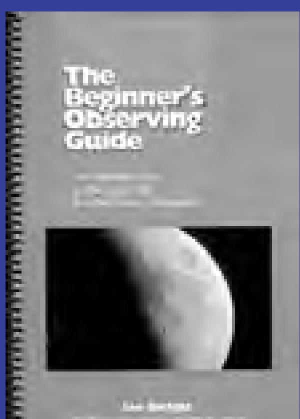

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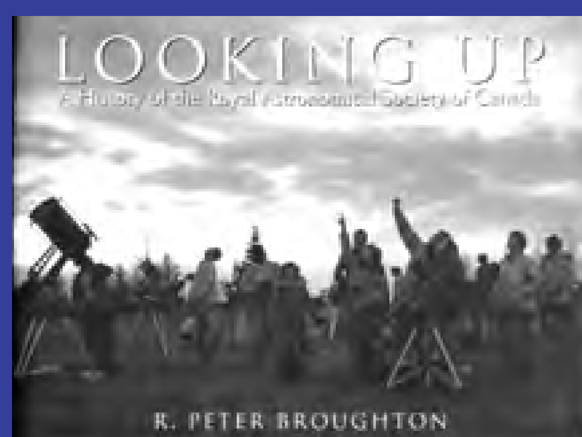

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