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Journal

The Journal of the Royal Astronomical Society of Canada

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We are Stardust

CELEBRATING 100 YEARS OF PUBLICATION

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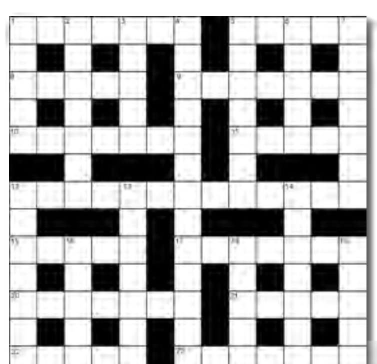

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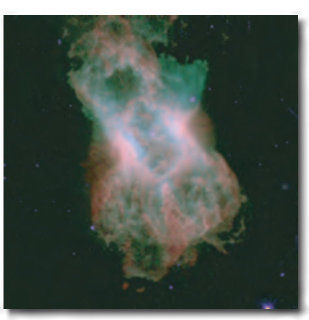
On the Cover:

Stuart Heggie acquired our cover image of M16 and The Eagle Nebula using an SBIG ST-10XME CCD camera on an Astro-Physics AP155EDF refractor, autoguided on an AP900GTO mount. Exposures were 6x30 minutes in Hα, 4x10 minutes in each of R and G, and 2x10 minutes in B.



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COLUMNS / RUBRIQUES

Editorial

by Jay Anderson, Winnipeg Centre (jander@cc.umanitoba.ca)

The Gift of the Magi

I am one of the Magi. You know — one of those guys (they were all guys then) who ride around on camels, loaded down with perfumes, money, and spices, watching the stars, and looking for omens. Wikipedia tells me that Magi also means shaman, sorcerer, or wizard in English, and that is closer to the context in which I want to use it. You are one of the Magi too.

We understand the stars, or should after a few years in the bosom of Mother RASC. We understand retrograde motions, and note their seasons. Lunar phases don't faze us. Comets, in their very strange orbits, seem perfectly natural. Eclipses are a treat: a spectacle placed in the sky to entertain, a lucky accident of geometry, a reason for travel. Meteor showers are an excuse to stay up past midnight in the hopes of a really impressive deluge. Orion is an old friend who arrives in the fall, stays the winter, and departs, reluctantly, in the spring.

Because we understand the cycles of the heavens, we are Magi.

Tell your co-workers that you were up the night before watching the Perseids, and you will be gifted with the status of one who is just a little more otherworldly than the rest. Mention a satellite transit of Jupiter, or a conjunction of planets, and the mantle of secret knowledge will settle on your shoulders. Acquaintances will acknowledge a hidden longing to know more of astronomy, though not sufficient to stay up late or seek a dark sky. A telescope will make you a hero at the cottage if there is a Saturn or Jupiter (or even a Moon) to be seen in the sky. Not a Muggle like the rest, but a Wizard, or at least a touch wizardly.

I was once fortunate to take a flight that reached altitude just at sunset on a night with a Full Moon; I had a window seat on the lunar side. Long blue-grey anti-crepuscular shadows decorated the cloud tops below me, converging on the Moon as it lifted above the cloud horizon. It was an Earth-sized geometry lesson, with Sun, shadow, and Moon all aligned to provide me with a private treat. When I looked around, no one was watching: I had it all to myself. I thought of interrupting my neighbour, to point out the alignment, and to share the magic. But I didn't.

Somehow, the secret pleasure was more rewarding than the public display. Keeping the mystery was more tempting than educating those around me. Or, perhaps private contemplation just permitted me the time to fully enjoy the moment. To be honest, just knowing something that none of the others knew was a bit of a secret pleasure too.

Journal

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

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Web site: www.rasc.ca
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Education is an important part of the RASC mandate, but somehow I cannot completely accept the "we'll bring it to you" part of that obligation. A telescope on Astronomy Day, catching the passing shoppers like a net in a fishing river seems too easy. It's like a magician giving away the trick. I want some minimum commitment beforehand — a person who seeks me out, who stays up late, who has already attempted to sail the heavens before asking for navigation lessons. I want the beginner who is ready to be a Wizard, and only needs the key to Hogwarts. The casual person who looks, comments, and passes on, is not ready for The Knowledge. Let them read books.

I prefer the star parties that get organized in the countryside — star parties to which parents must bring their children, to which students must beg a ride. They should be in hideaways where a small commitment is required. I prefer recruitment at a Centre meeting, finding newcomers in the audience who have enough Wizard blood to be curious and find us out.

It is a bit peculiar I admit, and the RASC could not fulfill its education mandate if everyone felt the same. However, it's a philosophy that seems to catch a common thread in our membership, and should be acknowledged and used. Not everyone in the RASC wants to attend the public star shows, showing off for the *hoi polloi*. You entertain them, entrance them, convince them, and then pass the acolytes along. We'll make them into Magi.

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

Research Papers
Articles de recherche

CALCULATION OF THE ATMOSPHERIC TRAJECTORY OF A METEOR FROM PHOTOGRAPHIC OBSERVATIONS

by Jeremy B. Tatum, Victoria Centre (jtatum@uvic.ca)

Abstract: In this article, it is shown how to calculate the atmospheric trajectory of a meteor from measurements of two photographs obtained from separate stations. Unlike visual observations by eyewitnesses, precise measurements rather than rough estimates are possible, but to achieve high precision it is necessary to take account of such details as the curvature of the Earth and atmospheric refraction. It is also necessary to record the time of occurrence of the meteor to a precision of a second.

Résumé: Dans cet article, il nous est montré comment calculer la trajectoire atmosphérique d'un météore à partir de mesures de deux photos obtenues par des stations séparées. Contrairement aux observations visuelles de témoins, des mesures précises plutôt que des estimations grossières sont possibles, mais pour obtenir une haute précision, il est nécessaire de tenir compte des détails tels que la courbe de la Terre et la réfraction atmosphérique. Il est également nécessaire de prendre en note l'heure de l'événement du météore à la seconde près.

1. Introduction

In an earlier paper (Tatum 1998), I described how to calculate the atmospheric trajectory of a fireball or meteor from visual eyewitness observations by the intersecting planes method. In brief, each observer would be asked to note two points on the sky track of the meteor. These two points and the position of the observer would define a plane. The second observer would do the same thing, and the intersection of the two planes would mark the atmospheric trajectory. The same broad principle applies for photographic records of a meteor by two separated observers, but there are many differences in detail. This article will describe how to determine the atmospheric trajectory from photographic records, and we start by drawing attention to the differences between the analyses of eyewitness and photographic observations.

2. Measurement

Eyewitness estimates of the essential angular data necessary for the investigator to complete the calculation are necessarily very rough and may commonly be in error by ten or more degrees. On the other hand, there may be an overwhelming number, perhaps hundreds, of witnesses, and the errors in the combined observations may be sufficiently reduced to make a credible calculation worthwhile. It is rare, however, for more than two separated observers to obtain simultaneous photographs of a single meteor. Recent successful pairs of photographs by amateurs include a Leonid photographed from two stations in Canada by Burgess and Boschat (Bishop 2003, and Tatum and Bishop 2005) and a Perseid photographed from two stations in England by Vincent and Bone (Bone 2006). Photographic records offer the opportunity for precise microscopic measurement rather than rough estimation. Eyewitness estimates of angles are typically made with reference to various fixed landscape features such as buildings or trees, and it is not actually necessary for the purpose of the calculation of the atmospheric trajectory to know the time of the observation (although this will be needed in order to calculate the pre-encounter orbit). Nighttime photographs, however, offer the opportunity to measure the meteor against the background stars. To make the best use of this opportunity, it is desirable that the time of the appearance of the meteor, and the times of the beginning and end of the (usually time-exposed) photograph, be recorded to the nearest second. To do this obviously offers some challenges to the inventiveness of the meteor photographer, but, if it can be done, it may then be possible for the measurer to determine the height of the meteoric particle to a precision of a very few tens of metres. This potential precision is very much worsened if the times are recorded only to the nearest minute. The reason for this is that measurements against a star background give the right ascensions and declinations of positions of the meteor track. It is then necessary to convert these (by well-known solution of a spherical triangle) to altazimuth coordinates, and, for this, it is essential that the time be precisely known.

After a pair of successful photographs of a single meteor has been obtained from two stations, which I shall refer to as P and Q, separated by at least several tens of kilometres, the photographs must be measured, and the atmospheric trajectory must then be calculated, and it is to those who must carry out such measurements and calculations that this article is chiefly addressed. To this end, a certain amount of experience on the part of the reader is assumed. The measurer should have some practical experience in astrometric measurement and be familiar with how to calculate the astronomical coordinates of an object from measurements on a photographic film (see, for example, Tatum 1982). It is assumed that the investigator knows how to do the basic calculations of spherical astronomy, such as the conversion between equatorial and altazimuth coordinates, and the trigonometric solution of plane and spherical triangles, and is familiar with the direction cosine matrix for converting between coordinate systems, and with least-squares regression. It is also supposed that the reader is familiar with the intersecting planes method in the "flat Earth" approximation as described in my 1998 article *(loc. cit.)*. Necessary formulae from these areas will not be explained in detail, and the reader who is unfamiliar with them may not be able to follow all parts of this article.

There are likely to be some considerable differences between the astrometric measurement of a meteor photograph and of an asteroid photograph, and the measurer who has had experience in asteroid astrometry may find him- or herself in unfamiliar territory when faced with the measurement of a meteor photograph. Today, practically all asteroid images are obtained with a digital detector, such as a charge-coupled device (CCD). Several versions of software are available for carrying out both the measurement and the subsequent calculation automatically, and with astonishing speed and exquisite precision. Indeed, it is quite possible for a person with relevant computer expertise to carry out the entire operation successfully, literally without knowing the difference between a sine and a cosine. The facility with which a modern computer in the hands of someone without detailed mathematical knowledge can carry out accurate astrometry is not, however, entirely without disadvantages. For example, for astrometry of the highest precision, certain corrections have to be made to the catalogued positions of the comparison stars used in the measurement. These include, for example, such things as differential refraction, differential aberration, optical (pincushion or barrel) distortion, proper motion, and possibly even annual parallax. It is likely that not everyone who has made use of a purchased astrometric package truly knows for certain which *(if any!)* of these corrections has been incorporated into the package. Not all of these corrections are of equal importance, and it is necessary to know which are important and which can be neglected in a particular application.

While some meteor observers are experimenting with digital detection (see especially the paper by Trigo-Rodríguez *et al.* (2005) for current progress with digital meteor detection and astrometry), it is likely, for a while at least, that most meteor photographs suitable for astrometry will be obtained with a wide-field camera and a photographic emulsion, as indeed were both of the pairs of photographs referred to above. It is true that such photographs can be scanned and digitized, but there may not necessarily be any purpose in doing so. Most digital astrometric packages may be well suited to measuring a point object such as an asteroid, or even a diffuse and asymmetric object such as a comet, but they may not be at all well-suited to measuring a long meteor track of variable width, and there may in practice be little alternative to measuring the photograph, tedious though it may be, with a precision measuring microscope.

The determination of the position of an astronomical object on a photograph entails measuring the coordinates of the object itself as well as of several comparison stars. In the case of a meteor, we need the positions of two points along its track in order to define one of the planes of the intersecting planes method. For an eyewitness observation, these two points are generally the first and last points along the sky track of the meteor. With a photograph, however, we have the opportunity of measuring many points along the length of the track, and we can then determine the least-squares straight line that describes the track. As to the question of whether this line should be the least-squares regression of y upon x or of x upon y, the answer is that, unless there is reason to think otherwise, the least-squares straight line should be one that minimizes the sum of the squares of the perpendicular distances of the measured points from the final regression, in a manner that will be familiar to those to whom this article is mainly addressed. Then, having determined the least-squares straight line, any two points on it, together with the observer's position, will define one of the two necessary planes.

The aim of the measurement will be to determine the altitude and azimuth of several points along the sky track of the meteor, and to do this the measurer will need to know the altitude and azimuth of the several comparison stars, and will be working in altazimuth rather than equatorial coordinates. Thus, it will be necessary to calculate the altitude and azimuth of the comparison stars, and this is why it is important to know the exact time of appearance of the meteor and the start and end of the exposure. The calculation of the altitudes and azimuths of points along the meteor's track from the instrumental measured coordinates follow from the usual method of plate reduction.

The standard method of reduction is not described here, since it is presumed to be familiar to anyone who has proceeded thus far with the present article, and it has been described by the author in an earlier article (Tatum 1982). Just one point will be made, however. Reference has been made above to the several corrections to the positions of the comparison stars, which should in principle be made for very precise astrometry. Which of these is really essential in the present context? Usually meteor photographs are wide-field and small scale. Because of the small scale, it is probably not necessary to correct for proper motion of the comparison stars. But, because of the wide field that is typical for meteor photographs — perhaps 10 or 20 degrees — it is *essential* to correct the altitudes for refraction and for differential refraction (*i.e.* the difference between the atmospheric refraction at the top and bottom of the photograph), and the measurer who fails to do this is remiss in his or her duties. If θ is the true zenith distance of a star (*i.e.* the zenith distance that it would have in the absence of Earth's atmosphere), and θ' is its apparent zenith distance, then, unless the star is very close to the horizon, the following formula (Smart 1962, Chapter III) is adequate for the atmospheric refraction μ:

$$\mu = \theta - \theta' = 58''.2 \tan \theta'. \quad (1)$$

The differential refraction is given by

$$d\mu = 58''.2 \sec^2 \theta' d\theta'. \quad (2)$$

For example, at a zenith distance of 60°, and a photograph of height 10° (and meteor photographs may often be larger than this), the difference between the refraction at the top and bottom of the photograph amounts to about 41″ — a difference that would be quite unconscionable to ignore.

It is entirely legitimate to raise the question as to whether the meteor is subject to the same amount of atmospheric refraction as the stars. After all, the stars are certainly beyond the atmosphere, but the meteor is partly embedded in it, and light from it is subject to only the lower part of the atmosphere. However, typical meteor heights are of the order of 100 km, and it would be very rare — though certainly exciting — to have a pair of photographs of a fireball at a height of a mere 20 km or so. In either case, the meteor is well above the troposphere, where by far the greatest amount of the refraction takes place, so it is very unlikely that one need to worry about different effects of atmospheric refraction on meteor and comparison stars.

At this stage, it is assumed that the investigator has measured both photographs and has determined, for each photograph, the zenith distances and azimuths of two points on the sky track of the meteor. Each of these measurements defines a plane. The investigator has been able to determine the equation to these planes. However, the equations to these planes are referred to two different coordinate systems centred at the separated positions of the two observers P and Q, and, because of the curvature of Earth's surface, their axes are inclined to each other. Our aim must be to refer the equation of each of the two planes (*i.e.* the plane containing the meteor path and station P, and the plane containing the meteor path and station Q) to the *same* coordinate system, which I choose to be the one centred at P. The next section takes up the procedure from here.

3. Calculation

We start by setting up three rectangular coordinate systems, P*xyz*, Q*x′y′z′* and Q*x″y″z″*(Figure 1). The first of these has its origin at the position of observer P. The *x*-, *y*-, and *z*-axes are directed, respectively, towards his east, north, and zenith. Zenith distance θ is measured from the *z*-axis, and azimuth ϕ is measured counterclockwise from the *x*-axis, according to the usual convention for spherical coordinates. Likewise the second coordinate system has its origin at observer Q and the *x′*-, *y′*-, and *z′*-axes are directed towards her east, north, and zenith. In the Flat Earth approximation, appropriate for eyewitness observations, these two systems are related to each other by a straightforward and easy-to-calculate translation. For precise

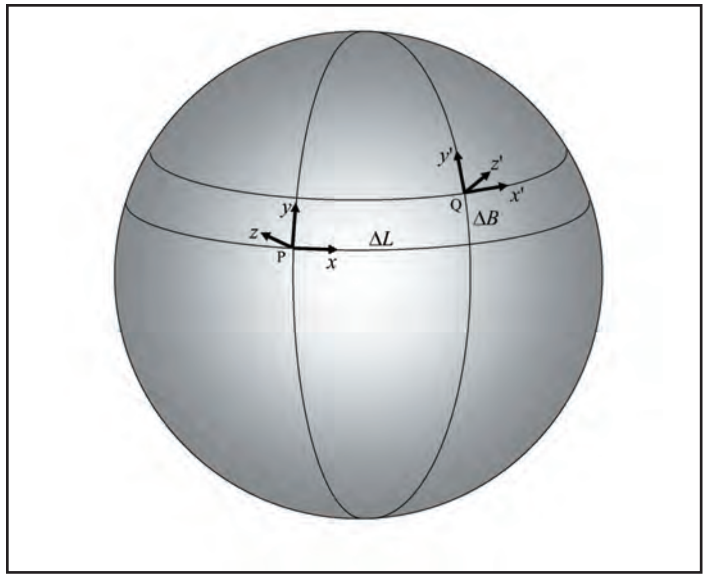

Figure 1 — Defining coordinate systems centred at the two observer stations.

photographic measurements, the Earth is not flat, and the two systems are related by a translation (which is not quite as straightforward as in the Flat Earth case) and two rotations, and we shall need, a little later, to be able to convert between them. To this end we shall need the third coordinate system, Q*x″y″z″*, whose origin is at Q, but whose axes are parallel to those of the P*xyz* system.

Let us first deal with the photograph obtained by P. Let (θ_1, ϕ_1) and (θ_2, ϕ_2) be the zenith distance and azimuth of two points on the sky track of the meteor. Then, as shown in my 1998 article (Tatum 1998), the equation to the plane containing the observer P and the atmospheric trajectory of the meteor is

$$ax + by + cz = 0, \quad (1)$$

where $$a = \sin\theta_1 \cos\theta_2 \sin\phi_1 - \cos\theta_1 \sin\theta_2 \sin\phi_2, \quad (2)$$

$$b = \cos\theta_1 \sin\theta_2 \cos\phi_2 - \sin\theta_1 \cos\theta_2 \cos\phi_1 \quad (3)$$

and $$c = \sin\theta_1 \sin\theta_2 \sin(\phi_2 - \phi_1). \quad (4)$$

Likewise, we have for the plane containing observer Q and the atmospheric trajectory of the meteor, referred to the Q-centric system,

$$a'x' + b'y' + c'z' = 0. \quad (5)$$

What we need to do now is to refer plane (5) to the Q*x″y″z″* system.

Suppose that the east longitude, north latitude, and height above sea level of P are (L, B, h) and that the corresponding coordinates for Q are $(L+\Delta L, B+\Delta B, h+\Delta h)$. The Q*x″y″z″* and Q*x′y′z′* systems are related though a rotation ΔL in longitude, and ΔB in latitude, the single-primed and doubled-primed coordinates being related by a rotation matrix as follows:

$$\begin{pmatrix} x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} -\sin\Delta L & 0 & \cos\Delta L \\ \sin\Delta B\cos\Delta L & \cos\Delta B & \sin\Delta B\sin\Delta L \\ -\cos\Delta B\cos\Delta L & -\sin\Delta B & \cos\Delta B\sin\Delta L \end{pmatrix} \begin{pmatrix} x'' \\ y'' \\ z'' \end{pmatrix}. \quad (6)$$

On application of this transformation to equation (5) we obtain the equation of the plane containing observer Q and the atmospheric trajectory referred to the $Qx''y''z''$ system. The equation will be of the form

$$a''x'' + b''y'' + c''z'' = 0. \quad (7)$$

We now need to perform a translation in order to obtain the equation of the plane containing observer Q and the atmospheric trajectory referred to the Pxyz system. To this end, I assume that the sea-level geoid is an oblate spheroid of equatorial radius R_0 = 6378.1 km and semi minor axis R_{90} = 6356.8 km. In that case, from the geometry of the ellipse, the distance of a sea-level point at latitude B from the centre of the Earth is

$$R_B = \frac{R_0 R_{90}}{\sqrt{R_0^2 \sin^2 B + R_{90}^2 \cos^2 B}}, \quad (8)$$

and its distance from the Earth's axis (radius of a parallel of latitude) is

$$\rho_B = \frac{R_0 R_{90} \cos B}{\sqrt{R_0^2 \sin^2 B + R_{90}^2 \cos^2 B}}. \quad (9)$$

Some careful geometry will determine that to a very good approximation the necessary translation is then given by

$$x'' = x - \rho_Q \sin\Delta L, \quad (10)$$

$$y'' = y - R_Q \sin\Delta B - (\rho_P - \rho_Q \cos\Delta L)\sin B, \quad (11)$$

and $$z'' = z + R_P - R_Q \cos\Delta B + (\rho_P - \rho_Q \cos\Delta L)\cos B. \quad (12)$$

These equations are valid if P and Q are at sea level, R and ρ being calculated from equations (8) and (9). To allow for the heights of both above sea level, it suffices to add to each R the the corresponding h for each station above sea level, and to add the corresponding $h\sec B$ to each ρ.

By means of the rotations and translation represented by equations (6) and (10) to (12), we shall have obtained an equation of the form

$$Ax + By + Cz + D = 0. \quad (13)$$

which is the equation, referred to the Pxyz system, for the plane containing the meteor path and the observer Q. When combined with equation (1), which is the equation, referred to the Pxyz system, for the plane containing the meteor path and the observer P, this gives the atmospheric trajectory of the meteor, referred to Pxyz. These equations can be used, as described in my earlier article (Tatum 1998 — see especially page 80) to find the height of the meteor above the ground at any point along its path, the ground track of the meteor, and the extrapolated ground impact point — except that here the "ground" is the xy-plane rather than the surface of the Earth.

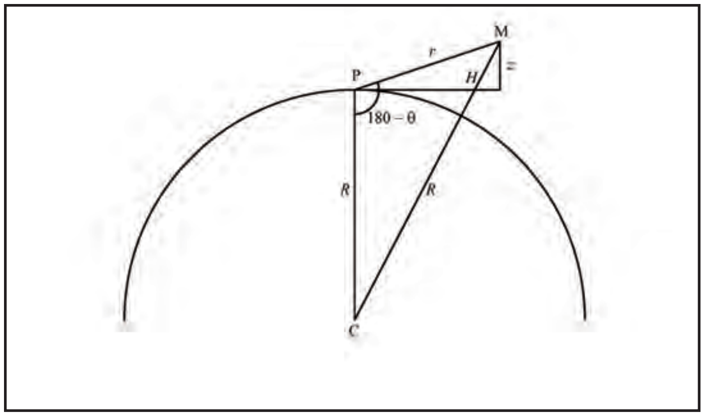

Figure 2 — Calculating the height H of the meteor.

Thus, at this stage, we can determine, for any chosen point along the path of the meteor, its coordinates (x, y, z) and hence its distance r relative to the observer P. Figure 2 shows how we can calculate the height H of that point above the Earth's surface. In Figure 2, C is the centre of Earth; P, of course, is observer station P; and M is some point on the meteor track at which we wish to determine its height H. The coordinates (x, y, z) of M are known, and hence also the distance r of M from P, in kilometres. The zenith distance θ of M is known, as is also the radius R of Earth. Thus, the distance CM and hence the height H can readily be found. This measurement and calculation can, of course, be done for many points M along the meteor's path, and hence its path through the atmosphere can be precisely delineated.

4. Conclusion

It cannot be pretended that the complete measurement and reduction of a pair of meteor photographs is anything other than tedious, and I have sometimes been impressed at the speed at which announcement of a bright meteor's path has been given, sometimes within hours of an event. Usually a thorough and careful investigation will take rather longer than this, but the possible result of being able to determine, reliably, the height of a meteor with a precision of a few tens of metres is ample reward for any tedium along the way.

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Dr. Jeremy Tatum is a retired Professor of Physics and Astronomy at the University of Victoria, where for 31 years he taught and conducted research on atomic and molecular spectroscopy, the composition of comets, and the orbits of asteroids — particularly near-Earth asteroids. An asteroid bears the name "Tatum" in honour of his work.

Feature Articles
Articles de Fond

Mars through the 2007 Apparition

by Murray D. Paulson, Edmonton Centre (murrpaul@telus.net)

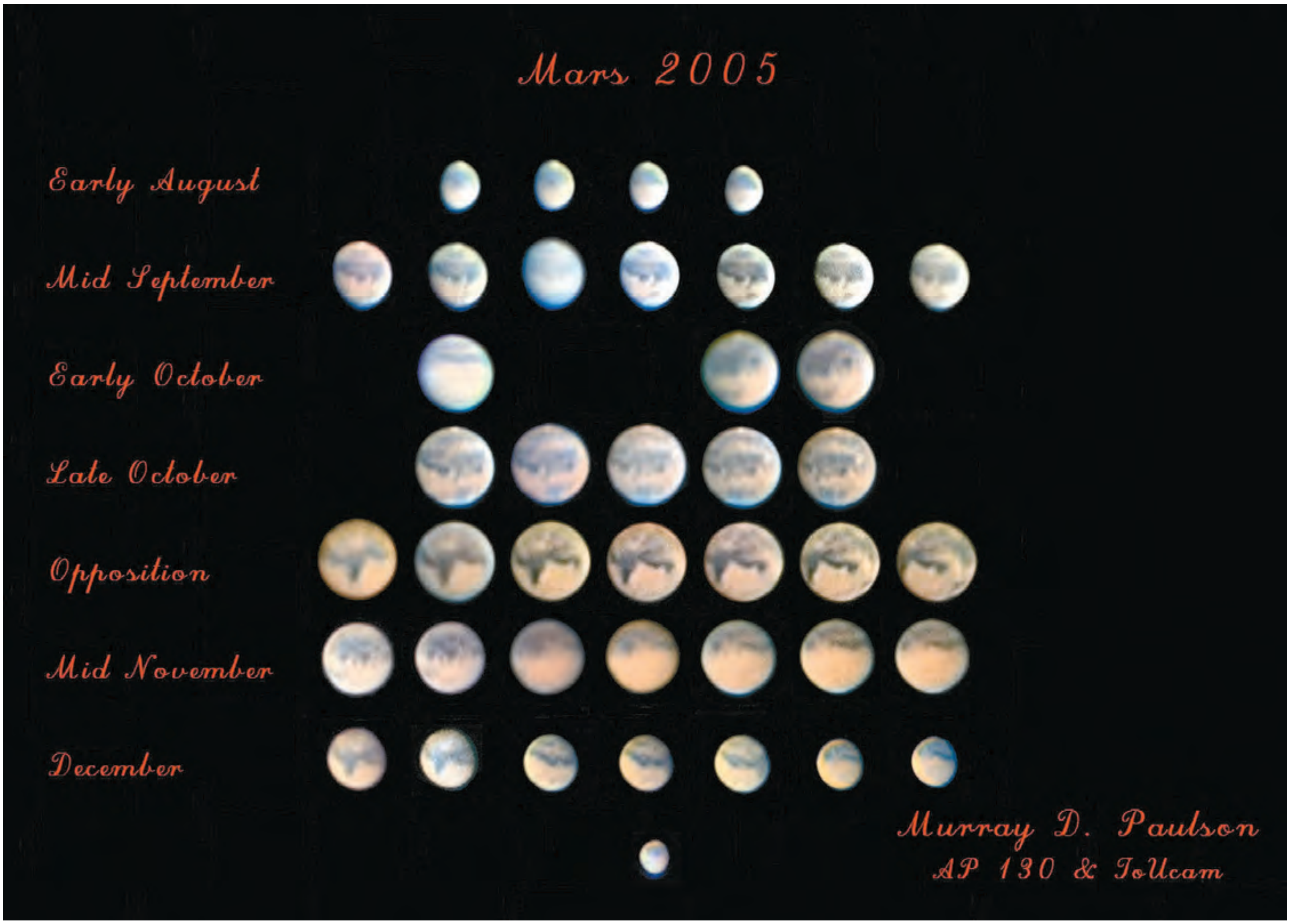


Figure 1 — This composite shows a sequence of my best images of Mars through the opposition in 2005, using an Astrophysics 130 at f/60 and Philips ToUcam. I took over 100 sets of AVI files, which were then converted to processed images using RegiStax.

You may have noticed that Mars is making its comeback in the morning sky. It will be swinging into the evening sky later this year, but I thought that you might enjoy getting familiar with it now.

Mars passed the Sun into the morning sky back in October 2006, and now, a year later, is poised for its next big show. Although 2003 was the closest approach in over 60,000 years, it was also very low in our Canadian skies. Despite this, it was a grand opposition and also the first where I imaged the planet instead of drawing it. Drawing Mars is a great way to give your eye time to find all those subtle details and to train yourself in the discipline of seeing. I heartily recommend it still, but a Web cam modified for planetary photography will beat my drawing skills and my eye every time. The 2005 opposition was arguably better than the 2003 opposition because it was so much higher in our skies, where the seeing was better. I imaged Mars over 100 times during that opposition, and many of the images accompanying this article are from that project. Since we have a bit of time to prepare for this opposition, I will give you my take on preparations for imaging and viewing Mars this apparition.

This month, Mars sits high in Gemini at a declination of +23.5 degrees. This is great for us — Mars will be small, but it is 'way up in the sky. At the beginning of October, Mars is 9.8″ in diameter and shines at magnitude -0.1. It rises at 10:30 p.m. and sits 1° south of M35. By the end of October, Mars will swell to a 12″ diameter and brighten to magnitude -0.6. It now rises just after 8 p.m., thanks in part to the fall of Daylight Saving Time (Yahoo!). December 1 sees Mars grow to 15.13″ at magnitude -1.3, and it sits in Castor's lap, the right-hand side of Gemini. At 11 p.m. Central Time, the great shield volcanoes face us, and Solus Lacus is looking at us from the edge of Mars's disk. Mars reaches greatest size on December 19 at 15.9″, and 5 days later it sits at opposition; it will shrink slightly to 15.79″ due to the relative motion of Mars to Earth. Remember that Mars is heading away from the Sun in its orbit, while the Earth is approaching perihelion. Santa won't be the only red object high in the sky! If you can grab some eyepiece time between festivities, you will see Syrtus Major centred on the disk.

Mars's North Pole is pointed towards M39, halfway between Deneb and Cepheus, and the planet's seasons are about three months ahead of Earth's. At opposition on December 24, it will be spring in its northern hemisphere. We should be seeing a good north polar hood and cap; the south polar cap will have disappeared. Mars rotates once in 24 hours, 37 minutes; therefore on successive nights you will see Mars 37 minutes earlier in its day. It takes 37 days before the same side of Mars is back in view at a particular time of night. To see what Mars has to offer on any night, take a look at its image from any one of a number of planetarium programs (*Guide,* for instance).

Imaging

My recommendations on imaging Mars this go 'round are to get your camera gear in order and do some practicing beforehand.

Figure 2 — This rotation composite shows a sequence of images of Mars taken every 30 minutes on the evening of 2005 October 29, with an Astrophysics 130 at f/60 and Philips ToUcam.

I use the Philips ToUcam with the Mogg adaptor and a UV blocking filter, plus a couple of Barlows and a laptop computer. I recommend a UV/IR blocking filter because these wavelengths will smear out due to atmospheric dispersion and degrade your images. You need the Barlows to get the f-ratio of your telescope up to the f/30 to f/60 range. Why? To get the most out of imaging, you want to magnify the image on the detector array, CCD, or CMOS so that you get below the resolving limit of your scope. This is called oversampling. If you undersample the image, you lose the fine details available in the image. I recommend setting the image scale at two to three times the resolution limit of your scope. Don't go too much over this because the image gets dim and exposure time will become too long. You will lose detail due to atmospheric blurring. There are occasions when haze or atmospheric extinction may force you to go to a lower oversampling rate, so you can maintain a reasonable exposure setting and not push the camera gain up into the noisy region.

$$\text{Oversampling rate} = \frac{\text{F-ratio}}{\text{pixel size in }\mu\text{m} * 1.778} \quad [1 \text{ to } 3]$$

For the ToUcam, pixels are 5.6 nm and with f/30, the oversampling rate is 3.0

$$\text{Arcsec/pixel} = \frac{116*1.778*\text{Pixel size in microns}}{\text{D*F-ratio}}$$

For a 130-mm aperture at f/30 with the Philips ToUcam, arcsec/pixel = .296″

My standard procedure is to set up my scope, polar aligned with Barlow(s), and get the camera in focus on the target. I set up with a small table right beside the scope within arm's reach of the focuser. I also image through my diagonal because I swap out the camera for eyepieces occasionally (remember to mirror the images after the fact). My setup moves from the garage to the deck, so polar alignment is only approximate, and I have to re-centre Mars in the scope if I leave it for any extended periods of time. I run the ToUcam in 320 by 240 mode, which bins the pixels 2 × 2 for a better signal-to-noise ratio. This forces me to use f/60 to get the desired image scale. The next step is to set up the camera's exposure, gain, and other settings for optimum performance. Depending on atmospheric conditions, I shoot at 1/25 to 1/50 second, which is enough to freeze the usual atmospheric turbulence. Make sure your gain settings do not saturate any part of the planet image. A dimmer image is better than an over-exposed video file. When you are ready to image, set up your camera's software and take a movie with 700 to 1000 frames. I have found that the ToUcam has better signal-to-noise at lower frame rates; *i.e.*, five is best and ten frames per second is my maximum.

Processing

The next step is to process the video files with *RegiStax*. It automatically aligns the images in a two-pass process, and then stacks all the frames that are better than a user-defined lower limit. Stacking effectively increases the digital resolution. The ToUcam shoots at 8 bits/pixel, which is somewhat low for decent image processing, but stacking gives you 12 to 16 bits to play with. The software then passes the image on to a "wavelet" imaging process that brings up subtle details that will dazzle you. I use *RegiStax,* but there are a number of applications out there that will do an admirable job of image processing and stacking, and I urge the reader to try them out.

RegiStax
K3CCD
AIP4WIN
Stacker

For your particular camera, experiment and determine what is best for your setup. The best object to experiment on is the Moon. It requires about the same exposure settings and will develop your skill in focusing and processing. The following list has the names of the cameras associated with some of the best images I have seen on the Internet.

Interesting cameras:
ToUcam
Lumenera
DMK firewire cameras
Mightex

Well, I have run out of month for producing this article, so we will continue in the next issue with the latest images and suggestions on observing Mars.

Murray Paulson has been interested in Mars for most of his life as an amateur astronomer and has written several articles on observing Mars for Astronomy *magazine. He currently uses a 5-inch APO and a 10-inch Dall Kirkham for observing the planets.*

Out of This World

by Guy Mackie, Okanagan Centre (guy.m@shaw.ca)

Members of the Okanagan Centre have a strong commitment to outreach that has evolved over the years from grassroots individual participation to an organized team of public outreach program volunteers in the communities of Kelowna and Vernon. Since our Sidewalk Astronomy program began in 2002, we have introduced Okanagan residents to the sky between First Quarter and Full Moons every month to date, with an average of 100 "eyepiece guests" for each event. Special events like the 2003 Mars close approach and International Astronomy Day have seen thousands of public guests entertained and educated by our enthusiastic volunteers. Since 2005, our public activities have been managed by our Outreach Director, Colleen O'Hare, who has organized our volunteers and synchronized their efforts with the community through public service announcements and email notices (see the Public Outreach tab at `www.ocrasc.ca`).

In 2006, we had a total of 110 public outreach events involving 17 members, contributing 655 volunteer hours directed toward the benefit of 15,000 public guests. There is no slackening of the pace thus far for 2007.

In 2006, we held 25 Sidewalk Astronomy events in the parking lots at Chapters and Wal-Mart and at movie queues for the *Pirates of the Caribbean* and *The Da Vinci Code*. We go where the people are, set up our telescopes, and let the night unfold. Using a *PowerPoint* presentation tuned to our audience, we made 33 classroom visits, introducing the night sky to students from preschool to college level, often scheduling nighttime observing to complement the classroom experience. Last year, we made seven visits to Girl Guides, Scouts, and the Boys and Girls Club. We have volunteered yearly as Night Sky Guides for community fund-raising events such as the Cancer Relay for Life and Free the Fuzz (Special Olympics). In 2006, we conducted 33 observing events in conjunction with Parks Alive, an ongoing community initiative to enrich the value of our public parks. We have also sponsored several outreach visits to our dark-sky observing site, where volunteers help novice members with their first steps into the dark. On the opposite side of the age spectrum, we have enriched the education of members of the Society of Learning in Retirement (`www.slrkelowna.ca`) astronomy students.

At our Kelowna dark-sky observing site, we are able to trace out constellations with laser pointers and share views of many deep-sky objects, capturing the imagination and an appreciation of astronomy for our novice and public guests. Light-polluted Sidewalk Astronomy parking-lot sessions are limited to views of the Moon, bright planets, and the Sun (these using filtered telescopes and our Society's (Kelowna area) Personal Solar Telescope). The enthusiastic appreciation of our guests confirms that no astronomical observation deserves to be missed. We back up visual observations with numerous handouts giving information on the objects we are observing, astronomy topics ("Welcome to Astronomy," "Illustrated Messier Catalogue"), and our Society.

We are currently building a public observatory that will enrich the astronomical culture of our community and complement our ongoing outreach programs of Sidewalk Astronomy, educational presentations, and community partnership.

A New Telescope for the Okanagan Centre

by Jim Tisdale, Okanagan Centre (jimbit@shaw.ca)

In 2002, an 8-inch reflector was donated to the Okanagan Centre from the estate of Don Norris. Due to its complexity, the scope was considered unsuitable for inclusion in our ever-growing fleet of rental scopes. This led to the idea of the development of a public observatory, where this scope could be used to its full potential, serving both our members and our community. Our members developed a detailed vision of the goals and mandate for this observatory based on two main features: a suitable dark site and an observatory that would serve the public.

Except for a brief interruption while our Centre hosted the very successful 2005 General Assembly, our members continued to plan the general vision and purpose of the observatory project and registered our Centre as a non-profit society in B.C.

In 2006, the family of telescope-maker Heinz Lorenz donated a 24-inch Zerodur mirror to the National organization of the RASC. This mirror was offered to the 28 Centres of the RASC in a competitive bidding process. Utilizing our many years of previous planning and the strong astronomical appreciation of our community, the Okanagan Centre's bid was a clear winner, and member Alan Whitman traveled across Canada in May of 2006 to take possession of our new mirror. The mirror is currently in Edmonton being refigured to optimize its configuration for public use.

Under the direction of Dave Gamble, the telescope committee is currently constructing the folded light path Optical Tube Assembly that will support the 24-inch mirror. Location Committee Chair Jim Tisdale has selected an excellent dark site high on the plateau east of Kelowna. Jim Failes, the Structure Committee Chair, indicated that he savours the challenge of making a facility that will support wheelchair access to the eyepiece for direct visual observation. Dave Collins holds the keys to the Finance Committee and is pleased that solicited funding has now started to roll into the project. Colleen O'Hare heads up the Media Committee, which has kept the paparazzi very interested in our project with a front-page article in our local print media. As part of the Media team, Grant Rice has done an excellent job as Webmaster for our observatory Web site at `www.okanaganobservatory.ca`.

Figure 1 — An articulated eyepiece will allow wheelchair-height viewing of the Cosmos. The eyepiece attaches to the telescope and extends down to the seated stargazer.

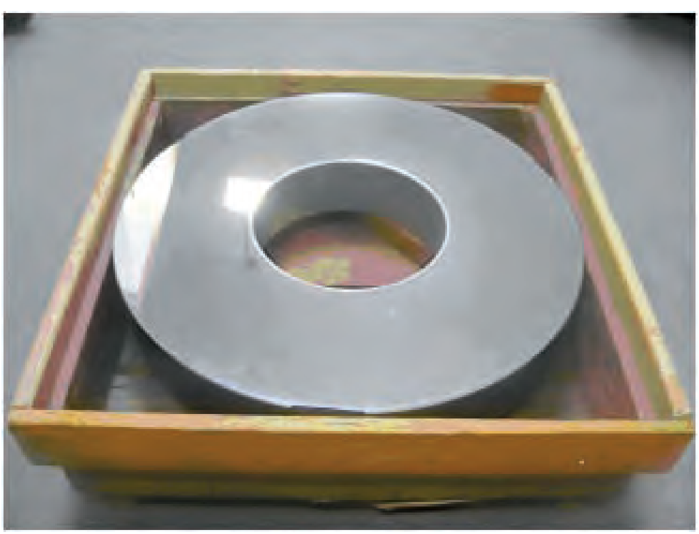


Figure 2 — A view of the 24-inch Zerodur mirror, selected for the new observatory telescope.

Figure 3 — These images show the initial design for telescope to be built around the 24" mirror and which will be housed in a domed observatory. This is one of the telescopes that will allow us to "explore the universe" with guests of the observatory.

David Player cracks the whip on the Work Party Committee, which is primed with many enthusiastic volunteers.

The spectacular growth and development of the Okanagan region has brought an innovative and progressive population to the valley. Development of a first-class astronomical observatory would be a strong tourist attraction, bringing even more opportunities for public enrichment. The long outreach track record of RASC Okanagan Centre members, combined with the climate, limited light pollution, and terrain of the Okanagan, promise an excellent location for the development and use of an observatory.

Since we started to promote the observatory project, many facets of our community have stepped up to endorse the project. Along with many others, these include the University of B.C., the City of Kelowna, Okanagan College, and our local School District. Such a level of support is very encouraging for the hard-working Okanagan Centre members, who will soon have an observatory to call their own.

The Prince George Centre of the RASC

by Gil Self, Prince George Centre (selfpg@telus.net)

For nearly three decades, the Prince George Astronomical Society has made positive contributions to life in our northern community. Our Constitution states that the purpose of the Society is, in part: "To provide programs for amateur astronomers to develop their skills in the sciences and to increase the general level of knowledge of astronomy and allied sciences in the community and school system." I think we do that quite well. Our members donate hundreds of hours to our community. Frequently people operate these kinds of organizations offering service to the public because they also can share in the benefit of facilities and equipment.

The question is, "Is volunteering for and working with the public perhaps the real benefit?"

Figure 1 — Members of the Prince George Centre gather in the evening twilight to begin a night of observing.

Prince George, B.C., is a relatively small city, fairly isolated. It is about a ten-hour drive to Edmonton or Vancouver. As such, people here are generally quite independent — creative at solving problems and getting things done with what's at hand. That type of community is very much reflected in our Centre. If you take a close look at almost any of the creations at our observatory, you will see evidence of this — in fact you will be surprised at how much is "homemade." If we can build it, we can spend the meagre funds in our bank account on other things.

You also might notice a good number of strange-looking parts. Yes, those assemblies holding up the dome started out as part of the front suspension of an older-model Ford. That counterweight looks like a winch drum (it is). The optical device that allows switching between CCD camera, film camera, and two eyepieces was designed and built after reading a book about the *Hubble Space Telescope*. The list goes on and on. Fortunately, over the years, we have attracted many talented people who are generous with their time and abilities. We have opened our observatory for Friday night public viewing 7 months of the year for nearly 20 years. During spring and fall observing season, we also book tours for schools and youth groups. The yearly count varies, but averages 40 to 50 tours a year. Our greatest resource is the people that volunteer their time. As with most non-profit organizations, there is a small core of dedicated members that staff most of these events, but it seems each year we happily welcome one or two new members who step right up and become involved.

The original idea for the Prince George Centre was the brainchild of Bob Nelson and Eric Hoogstraten back in 1979, when Bob was an instructor at the College of New Caledonia (CNC) and Eric was a student. The idea was to buy the mirror set and build both the telescope mount and observatory building. We envisioned at the time that the observatory would be used by the following groups:

- The astronomical Society (general observing and photography)
- Serious amateurs and college staff (research)
- The general public (public observing nights)
- District 57 and the college (field trips)

We quickly put together the fledgling Prince George Astronomical Society (PGAS) from members of the astronomy class that Bob taught, and the Society was formally incorporated on 1980 April 18. Soon after formation of the Society, we applied for a grant for $12,600 from the B.C. Lotteries Corporation, receiving all that we asked for in November 1979.

In December 1979, we purchased a used silo dome in Abbotsford and trucked it back to Prince George on a U-Haul trailer. Reconditioning and conversion to an astronomical dome was accomplished during the spring and fall of 1980.

In May 1980, the CNC Heavy Equipment Operators' class cleared the building site up on the south slopes of Tabor Mountain and built us a driveway.

Figure 2 — Construction of the Prince George Astronomical Society's first observatory on the slopes of Tabor Mountain in the fall of 1980.

In the fall of 1980, members of the Society — with the help of professional bricklayers — built the silo-like structure that was to house the observatory; we moved the dome into place on 1980 October 30. Over the next few years, we poured a massive pier that was to support the telescope and finished the interior of the building.

The telescope, a massive steel structure weighing close to two tons and designed by Eric Hoogstraten, was constructed at the college beginning in 1980. The mirrors arrived in May 1982 and, after testing, were carefully stored away.

By 1984, everything was ready, and on June 28 the big telescope was moved to its new home. Ken Hewitt-White of the H.R. MacMillan Planetarium officially opened the observatory in September, and we held our first public observing session.

Over the years from 1984 to 1988, we held numerous tours and public observing sessions, the most notable of which was on 1986 January 11, when we had some 50 people to view Halley's comet.

Sadly, the observatory lacked security. Over the years, we had three break-ins, resulting in the loss of numerous items. The most serious was in July 1988, when thieves stole the secondary mirror, resulting in the closure of the observatory. May 1991 brought the final blow with the news that the Ministry of Transport would cease ploughing the road to the site in winter. We had to seek a new site.

In June 1991, we held a casino event (one of many), raising some $4400 for a new observatory. In the same month, we located a new site west of Prince George, applied for and shortly after obtained a license for occupation. During the following winter, we planned the new building with the help of local architect Dave Dennis.

Figure 3 — Loading the dome: the new telescope frame is lowered into place in the Tabor Mountain observatory.

During the summer and fall of 1992, we erected the first stage of the new observatory. It was a 20′×26′ block building, heavily reinforced by iron rods, and lacking any windows (for security reasons). Professional help was used when needed (pouring concrete, laying cinder blocks), but other than that, construction was by volunteer labour. On 1992 October 20/21, the dome and telescope were moved from Tabor Mountain to the new site on Tedford Road, though first light did not come until the following year.

Figure 4 — The dome for the new observatory is loaded into place in 1992.

In November 1992, we applied for two grants: $25,000 from the Ministry of Higher Education and $16,000 from the B.C. Science Council. By April 1993, the money was on hand. In May and June of 1993, Bob Nelson and Ted Biech, working every day without any time off, erected — with professional help where required, and volunteer help on weekends — the classroom addition to the observatory.

Although not finished inside, the building was fully closed in by mid-July.

Over the next four to six years, we framed the interior, installed the electrical system, added insulation and drywall, and installed a water and sewage system, including a bathroom. Natural gas and a furnace came in 1994. In September 2003, the club purchased its first digital projector, greatly enhancing the quality of the very popular public shows that we have developed. Our upgrade/deficiencies list seems to mirror Medusa and her Gorgon sisters: cross one item off and two more appear. We did a "to-do/upgrade/want" list a few months ago that was a couple of pages long.

In keeping with the trend of adopting GOTO technology, our trusty 0.6-m telescope is in the middle of its upgrade. A new Dec gear and worm drive, new stepper motors for both RA and Dec, and controller boards will complete the latest portion of the upgrade. This will allow click and point with any ASCOM-based software.

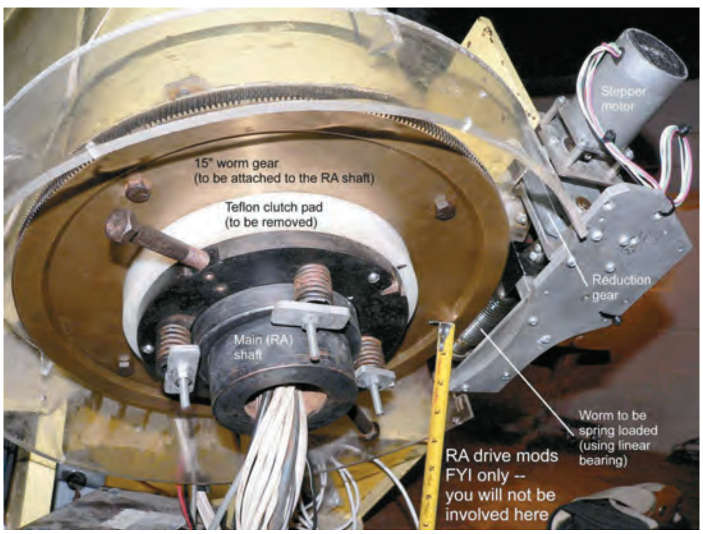


Figure 5 — A close-up of some of the working parts of the new telescope.

A new, modified, aluminum Serrurier truss is also under construction and an electro-magnetic lock mechanism for our remotely-controlled secondary rotator is in the works. This will allow the telescope to change from a Schmidt-Cassegrain to a Newtonian at the push of a button. A new powered focuser for the "Newt" is being designed and the primary mirror will see new cooling equipment. This will provide more-uniform temperature across the mirror and reduced cool-down times.

The list of improvements is not limited to the optical operation of the telescope. New bearings and adjustable housings are being installed for the main dome, as well as a new dome drive assembly to replace the Armstrong crank. Our upgraded viewing area boasts four permanent concrete piers, each one equipped with universal mounting bases to accommodate any type of telescope mount. Each mount can provide AC power, 12-volt DC power, access to the observatory computer network, video feed capabilities, and the ability to operate telescopes remotely from inside the observatory. Night visibility around the piers is accomplished by the incorporation of dimmable red LEDs at each station.

Figure 6 — A 2004 aerial view of the Tedford Road observatory showing the observing decks, piers, and the classroom, set among the trees of B.C.'s northern forest.

Secondary telescopes have not been forgotten. The Society and club members own, collectively, 6 to 8 telescopes in the 10-inch to 14-inch size. These instruments are valuable additions to the big telescope, as they permit the viewing of many more objects during busy tours or public observing sessions. We also have four portable Newtonians that we use as loaners.

On 2001 April 26, the PGAS joined the RASC, and officially became known as the RASC Prince George Centre. This move has resulted in greater contact with astronomers from across Canada, access to greater resources, and larger Centre membership overall.

In 2005, the RASC Prince George Centre implemented a meteor-detection project using information obtained from the Sky Scan Awareness Project and a program called Radio Sky-Pipe. Two FM automobile radios tuned to 98.7 MHz, a Yagi antenna, and a Quadrifilar Helicoidal antenna enable us to collect data, which is published to our Web site every 15 minutes. The audio component of the monitoring activity is sent to the viewing deck and has proven to be immensely popular with the public when they are viewing meteor activity at our public events. The output from the meteor-detection system can be viewed at `www.vts.bc.ca/pgrasc`.

Data from Radio Jove, which monitors radio emissions from Jupiter, continues to be accumulated.

Long undeveloped, the observatory's Telescope Control Room was finally finished and is now home to the computer required to control the main telescope, and computers that collect meteor and Jupiter data. The room is also being used as an office, and a library for books, VCR tapes, and DVDs.

Two of the observatory computers, hosts in the team "PG

Figure 7 — "HAL 2003." The rack contains the operational heart of Radio Jove, the meteor detection system, and video and network distribution for the building and all the piers.

Data Crunchers," are used to process data for SETI, Einstein, and Rosetta. More information about this activity will be forthcoming in the Centre's Annual Report.

Prince George Centre also has active education and public-outreach programs consisting of Public Viewing Nights, Group Tours, an Armchair Astronomy Course, and the New Observers to Visual Astronomy (NOVA) course.

The Prince George Astronomical Observatory (PGAO) is open to the public seven months of the year. Open Houses (public viewing nights) occur on Friday evenings in the fall from August to November, and again in the spring from March to May. During an Open House the public can "drop in" and view celestial objects through the 0.6-m telescope, view constellations via a laser-pointer show, watch an astronomical video on the data projector, or see a lecture presentation. While all these activities are available, they don't necessarily all occur every Friday, but vary depending on who is running the Open House and what is happening in the sky. Attendance at Open Houses varies from a handful to a few hundred if something really exciting is happening. The big Mars event a few years ago drew an estimated 1500 people in one night!

Figure 8 — Open house at the Centre's observatory.

Group Tours follow much the same format as the Open House, except that the facility is booked by one group. This allows us to tailor the presentation content to suit the audience and put on a more organized "show." Girl Guides book the most tours to obtain their Astronomy badges, but many other groups book tours as well. Audiences for these tours range anywhere from the Youth Correctional Facility to birthday parties.

The Prince George Centre offers two astronomy courses. Armchair Astronomy is offered at the University of Northern British Columbia (UNBC) through their Continuing Education department. It is a two-day course designed to be a quick introduction to amateur astronomy. It was offered for the first time in the fall of 2006 and will be offered again this fall.

The New Observers to Visual Astronomy (NOVA) course is run at our observatory/classroom facility. The course is nine sessions long and is run from October to May. Last fall we collaborated in offering the course through UNBC's Continuing Education program for the first time. The Prince George Centre runs the course but we use UNBC's Continuing Education advertising and Web site to reach and register students. UNBC takes a small cut of the course price to pay for the advertising and Web site maintenance. This has worked well for us, reducing the amount of work on our end to register the students, and allowing us to advertise when we wouldn't otherwise be able to afford to do so. The program will be offered again in collaboration with UNBC this fall, but this year we will add a method of passing/failing students, so that UNBC can offer it as a credit course. The NOVA course material has been passed on to the RASC. It is maintained by the Education Committee and is available for download in the members' area of the RASC national Web site.

The Prince George Astronomical Society has grown over the years. We are very proud of our evolving observatory and technical facilities. But, above all else, our real strength is our members. We now have several social events throughout the year, as well as a capable team running a modern observatory and serving the community - they are a great group of friends.

Thanks to
Glen Harris
Blair Stunder
Brian Battersby
Bob Nelson

Gil Self, current President of the RASC Prince George Centre, was born on the Summer Solstice on 1948 June 21. Soon to retire from Xerox Canada, which will free up some time for his astronomy passion, Gil has served on many executive positions throughout his 15 years with the Prince George Centre. He also has edited the Centre newsletter, PeGASus, "forever" he says.

We are Stardust

by Bettina Forget

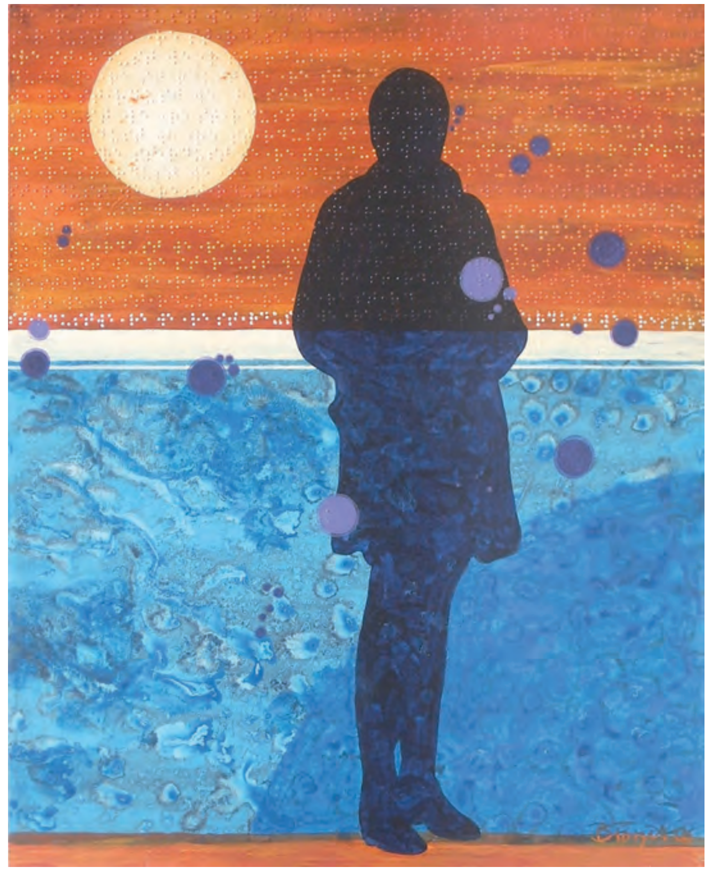
All the molecules that make up humans — in fact, the entire planet and everything on it - were created by an ancient exploding star, billions of years ago. This is expressed in astronomer Carl Sagan's famous quote "We are all made of star stuff," which is the inspiration for artist and RASC member Bettina Forget's latest series of works called *We are Stardust*.

Each painting in this series is inspired by a chapter in an astronomy textbook, and features the silhouette of the (in)famous female aviator, Amelia Earhart. Forget uses the silhouette as a symbol for all humankind, for our impermanence, and our connection to the stars.

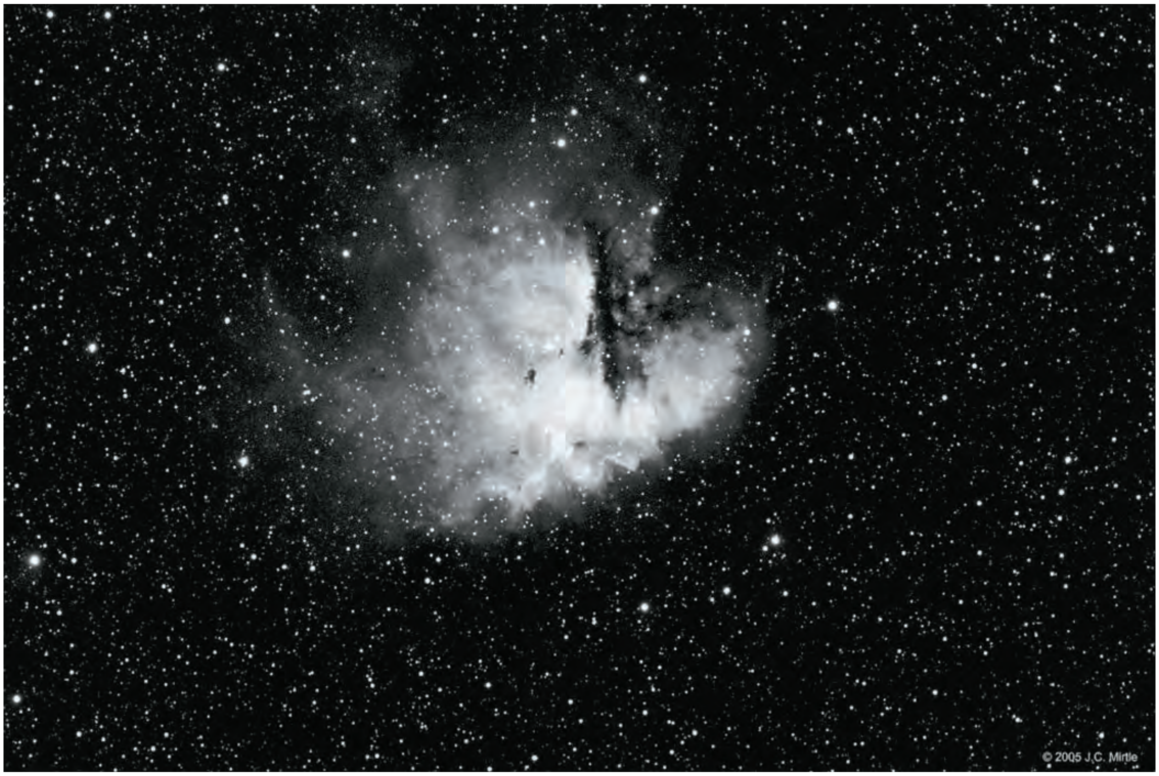
In the painting *We are Stardust ~ Pleiades* featured here, Earhart's shadowy silhouette is superimposed on the open star cluster Pleiades, also known as the Seven Sisters. The orange background on the upper part of the painting is covered in Braille writing, which repeats the phrase "We are Stardust" over and over.

If you'd like to see more works of this series, visit the artist's Web site at `www.bettinaforget.com`

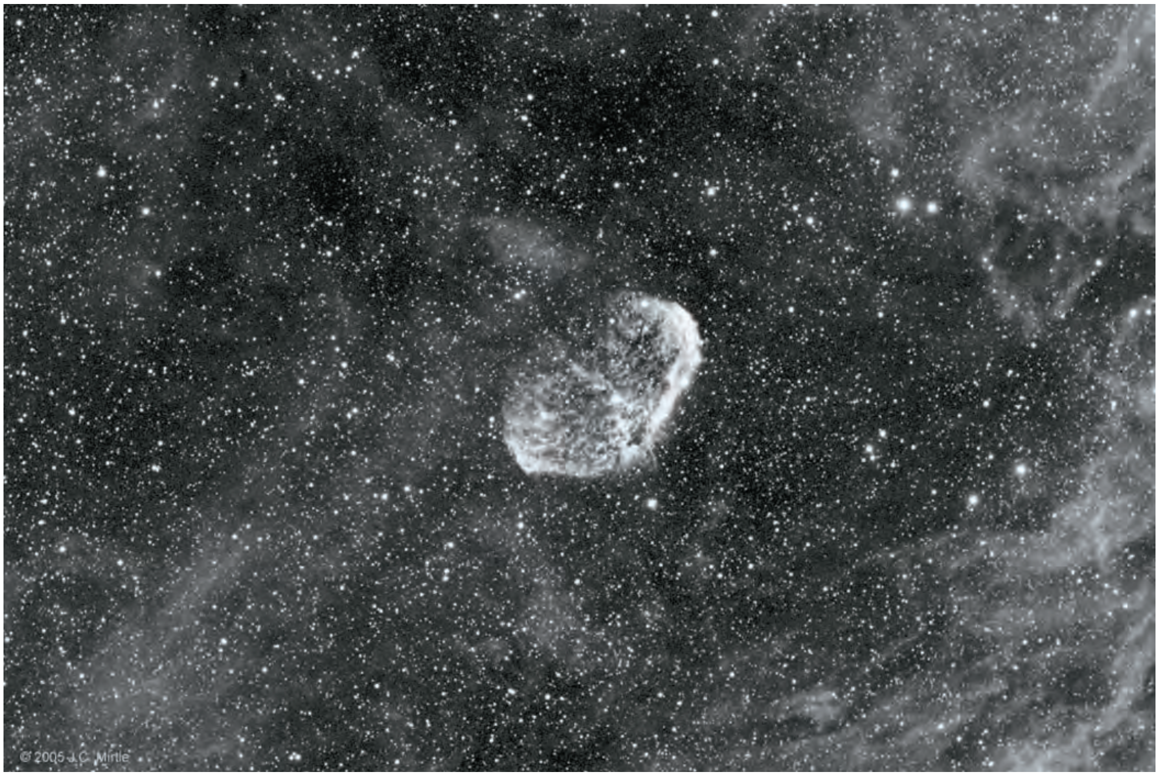
Editor's Note: Bettina Forget's painting *Fire and Ice*, juxtaposing the surfaces of Io & Europa in the same image, appeared on the back cover of the July/August 2007 issue of *Planetary Report*, a publication of The Planetary Society.



Bettina Forget
We are Stardust ~ Pleiades
2006
acrylic on canvas, 24″ × 30″



John Mirtle captured this image of the Pacman Nebula (NGC 281) in Cassiopeia from Mount Kobau on 2005 August 4 using a Takahashi FSQ-106N and an SBIG ST-8XE camera. The image is a composite of three 30-minute exposures through a Schuler 10-nm hydrogen-alpha filter. The Pacman Nebula contains all of the elements of a superb photographic target: a bright emission nebula, superimposed dark Bok globules, a small open cluster of stars, and lanes of obscuring dust and gas. It lies about 10,000 light-years distant.



The Crescent Nebula (NGC 6888) is an expanding shell of dust and gas surrounding an aging Wolf-Rayet star, seen here as the bright star near the centre of the emission. John Mirtle captured this image on 2005 August 2 using the same equipment and exposure as that for the Pacman Nebula.

Pickering's Triangle is a tangled mass of star ejecta in the western part of the Veil Nebula. This image of the top half of the Triangle was taken by the Toronto Centre's Paul Mortfield and Stef Cancelli using a 16-inch Ritchey-Chretien telescope and Hα, R, G, and B filters on an SBIG ST10XME camera.

This view of the edge-on galaxy NGC 891 comes from Albert Saikaley. While the dark dust lane is prominent when viewed visually, the photo shows a hint of fine dusty filaments that extend above and below the plane of the disk. These filaments may be caused by supernova explosions.

Dr. Claudia de Rham

by Philip Mozel, Mississauga Centre (phil.mozel@sympatico.ca)

From the southern location of Madagascar, all of the big-ticket items of the night sky— the Magellenic Clouds, Omega Centauri, and the Tarantula Nebula for instance — are available in all their glory to the skywatcher. The centre of the Milky Way passes high above. And the sky is dark! One can literally see the mysteries of the Universe spread out overhead. After spending a portion of one's youth with such a nightly sky show, it is not surprising that the stars beckon — as they did with Dr. Claudia de Rham.

Born in Switzerland, Dr. de Rham attended the French High School of Tananarive on Madagascar. She then studied at the Swiss Institute of Technology, the Ecole Polytechnique in Paris, and Cambridge University in the UK, obtaining a Ph.D. in cosmology, and beginning a globetrotting career. She is currently doing postdoctoral work in cosmology at McMaster University in Hamilton and the Perimeter Institute for Theoretical Physics in Waterloo. Cosmology, with its mysteries and interesting puzzles, was a logical subject of study, following naturally from her interest in physics, and those tremendous Madagascar skies. Not only has Dr. de Rham studied around the world, she has worked in a wide variety of locations, including as an intern at the Geophysical Observatory at Tananarive on Madagascar. While providing assistance to researchers there, she managed to obtain time on the observatory's telescope whenever it became free. She helped students at the African Institute of Mathematical Studies obtain their Masters degrees and, while an undergraduate at the Science Museum in Lausanne, Switzerland, helped to develop a teacher's guide for an exhibition dealing with the properties of light. During a sojourn as an intern at the Jet Propulsion Laboratory, she worked on Mars topography and looked for correlations between the planet's gravitational and magnetic fields.

This is a lot of moving around, and, when asked if this was largely planned, Dr. de Rham replies, "No, it just turned out that way." Since nothing has attached her permanently to one place, the notion of the whole world as her home developed naturally. She has certainly seen this world from various angles — from the back of a horse while show jumping, flying above it as a student pilot, or diving beneath it as a master diver.

By this point in the interview, I was ready, sort of, to ask about Dr. de Rham's research specialty. There was some apprehension on my part because the subject seemed just about unfathomable. Dr. de Rham was, thankfully, very patient as I simply and directly said, "Please explain braneworld cosmology."

Dr. Claudia de Rham

It turns out that this involves multiple dimensions, both seen and unseen. Our world is composed of three spatial dimensions plus one of time. This is all we can physically experience, as far as dimensions go. If other dimensions exist, they may be too small to see. This would be analogous, Dr. de Rham explains, to "every point in space being seen as a circle of such small radius that we would perceive them as simple points."

Invoking extra dimensions may allow the unification of all the fundamental forces, *i.e.* the weak force, strong force, electromagnetism, and the so-far-recalcitrant gravity, the weakest of the four. According to braneworld cosmology, our Universe consists of a three-dimensional "brane" embedded in a higherdimensional space-time called the "bulk." The Big Bang, for example, could be explained as the collision between two branes. The weakness of gravity, propagating as gravitons, is explained as due to gravitons leaking out along the extra dimensions and being diluted in the process. None of the other forces can make the crossing. Dr. de Rham likens living on a brane to living on the surface of a body of water, which we can easily see, while a vast ocean beneath remains undetected.

Now, if gravitons can wander from one brane to another, are other dimensions, other universes, detectable? Dr. de Rham points out that, in principle, it is possible to discover other dimensions. But, keeping in mind that not all braneworld cosmologies invoke multiple branes, finding one with another universe would be much more problematic. The graviton effect would be subtle since we have not yet detected other dimensions or branes. Of course, Dr. de Rham finds the possibility of such detection very exciting!

What might such observations be? Dr. de Rham says we start by asking, "What would be different if we lived on a brane?" Well, it turns out that Newton's laws would be different — at least on scales that have so far gone untested. For example, no one has looked at the gravitational force over distances of less than a micron, and for good reason. The required measurement accuracy is of such a high order that the experiment has been rendered impractical, at least for now. While testing gravity over various distances is the best way to check the theory, further investigations could be done by closely scrutinizing the expansion of the Universe or understanding the nature of dark matter and dark energy. One could also look for clues in the cosmic background radiation in ways similar to what has been done by the *Cosmic Background Explorer* satellite (COBE) and the *Wilkinson Microwave Anisotropy Probe* (WMAP), or will be attempted by the upcoming *Planck* mission. The goals of the latter include determining the geometry, contents, origin, and evolution of the Universe. Observations of the microwave background will be made with unprecedented accuracy and detail. At the other end of the size spectrum, high-energy collisions in particle accelerators such as the Large Hadron Collider at CERN, Geneva, may potentially offer a window onto extra dimensions.

Why search for branes from Canada? Dr. de Rham finds this country an exciting place to do science — a friendly, dynamic country affording lots of opportunity. And so, with such bright prospects, we can rest assured that, in the case of at least one scientist, there is not likely to be a "brane drain."

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

Pen & Pixel

Kevin Black of the Winnipeg Centre captured the Andromeda Galaxy and an errant Perseid meteor in this lop-sided image from the night of August 12. He used a Canon 20Da, a 15-mm f/5 lens, and an ISO setting of 400 for this 2-minute exposure. The camera was riding on a Byers CanTrak.

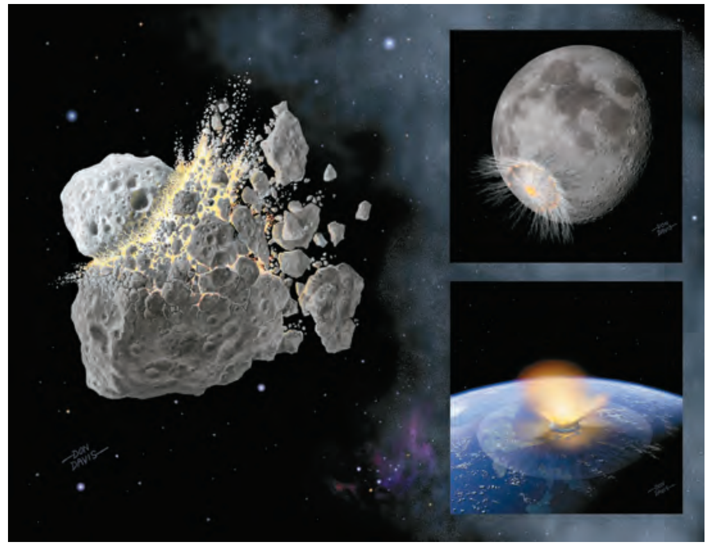
"Breaking Up is Easy to Do"

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

About 65 million years ago, an asteroid slammed into Earth, just off what is now the Yucatan Peninsula in Mexico. The destruction is widely believed to have resulted in a mass-extinction event, ending the time of dinosaurs. In order to hit the Earth, asteroids must be shifted off their (mostly) stable and roughly circular orbits in the main belt between the orbits of Mars and Jupiter to elliptical orbits that cross planetary paths. Bill Bottke, of the Southwest Research Institute in Boulder, and his collaborators, have now determined that the asteroid that ended the reign of dinosaurs most likely came from the break-up of a main-belt body about 160 million years ago. This break-up left behind the Baptistina family of asteroids and caused a doubling in the impact rate on the Earth of kilometre-sized bodies over the past 100 million years. The same break-up event also likely provided the body that created the bright Tycho crater on the Moon.

The asteroid 298 Baptistina is one of ~40 km diameter in the main belt, orbiting ~2.26 AU from the Sun, in a moderately eccentric orbit. Some 3000 observed smaller bodies have similar orbits and define the family. Asteroids smaller than ~3 km in diameter are believed to be there, but have not yet been seen by existing surveys. Based upon reasonable assumptions about the distribution of sizes, Bottke estimates that the break-up originally produced ~140,000 bodies with diameters >1 km, and ~300 bodies >10 km. From this, and simulations of break-up events, he concludes that the original body was ~170 km in diameter.

After the parent body was broken up, the debris evolved in several different ways. The remaining bodies collided with each other and with the main-belt population, grinding them down until the family distribution of sizes was the same as the main belt. In addition, sunlight affected the rotation and orbits of the smaller bodies through the Yarkovsky and YORP effects. The Yarkovsky effect is caused when asteroids heated by the Sun reradiate the thermal energy into space. Because the asteroid rotates, more heat is given off by the sunset side of a body than the sunrise side (the sunset side has been heated through the body's "day"). The radiated photons have momentum, resulting in a thrust towards the sunrise side of the body. If the body rotates in a prograde way (in the same direction as it orbits the Sun), it will gradually be pushed farther from the Sun. Bodies that rotate in a retrograde way will spiral in towards the Sun. The YORP effect is a variation on the Yarkovsky effect, wherein



An artist's conception of the break-up event that created the Baptistina family of asteroids, along with a representation of impacts on the Earth and Moon. Photo: Don Davis and Bill Bottke, SwRI, and *Nature*.

irregular shapes can affect the rotation of bodies in much the same way as pinwheels act when placed outside on a windy day. Although it sounds weird, both effects have been observed to act on real asteroids (*e.g.* Kaasalainen *et al.* 2007).

The family sits in a region that is in what is called a "mean-motion resonance" with both Jupiter and Mars. A resonance is where two bodies complete integral numbers of orbits, bringing them both back to the same point again and again. When the bodies are at closest approach (observationally, in conjunction), the gravitational force they feel from each other is at a maximum and always has the same orientation. When any body is in a resonance with Jupiter, it feels a small but consistent force that over millions of years will shift it to a new orbit, normally a fairly eccentric one, which could cross the orbits of the inner planets. Resonances with Jupiter are rapidly depleted of bodies, but the Yarkovsky effect ensures that there is a continued migration into the region, meaning that there is a continuous source of new Earth-crossing bodies until the family is sufficiently depleted that the migration rate drops to something like the steady-state resupply rate in the rest of the main belt. The YORP effect slightly modifies the Yarkovsky drift.

Bottke and his colleagues have modelled all these effects and tracked the evolution of the test bodies in the simulation.

They found that 1.7 percent of the bodies in the resonance with Jupiter and Mars hit the Earth over a 200-million-year period, with a peak ~40 million years after the break-up event and a gradual decline to the present-day flux of bodies. Their estimate is that the Earth has been hit by 200±60 objects with diameters >1 km, 6±2 bodies larger than 5 km, and 1±1 larger than 10 km. For the 1-km-sized bodies, this is about equal to the background flux of impactors on the Earth, which correlates with an observed doubling of impacts over the last 100 million years.

But how does this connect the family with the impactor that wiped out the dinosaurs? That body was estimated to be ~10 km in diameter, and the analysis of trace elements (in sediments from the north Pacific Ocean) indicate that it was similar to a carbonaceous chondrite (like the Murchison meteorite), which is consistent with the classification of Baptistina based upon optical and near-infrared observations. We also know that Murchison-like carbonaceous-chondrite-like bodies are only a small fraction of the current population of near-Earth asteroids, so it would be rather unlikely to come from that population. The current background of bodies ~10 km in size migrating out of the asteroid belt into near-Earth orbits is negligible (about one body hitting Earth every 350 million years). If the type of body is restricted to be a Murchison-like carbonaceous-chondrite, the impact rate drops to one every 3.5 billion years — effectively zero. As the flux from the Baptistina family is about one in the last 160 million years, it seems most likely that it is the source of the dinosaur-killing asteroid.

Bottke also links the Tycho crater on the Moon to the Baptistina family, but this is more tentative because the composition of the impacting body there is not known. The size of the crater suggests that the projectile was >4 km in diameter and the flux of such bodies from the Baptistina family hitting the Moon in the last 160 million years is 0.6. The background rate is one body in 570 million years. Bottke estimates that there is ~70 percent chance that a Baptistina asteroid created Tycho. In addition, Tycho was created right around the time of the peak flux from the Baptistina family break-up event.

Bodies larger than 100 km are broken up in the asteroid belt about every 200 million years, and some of them should have produced showers similar to the one from the Baptistina family — a rather dismaying prospect for any people who have to live through such precipitation.

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

Reference

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The Cheeseburger Nebula

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

If you are reading this column, you are almost certainly familiar with the bewilderment that non-astronomers have with our hobby. Why do we like looking up at the night sky? The answers of course are varied. Some find comfort in the near immortality of the stars, easing the angst that comes with pondering the shortness of a human lifetime. Others, perhaps with an environmentalist's heart, are soothed by the untouchability of the heavens, knowing that the grasping hands of land developers or mineral-exploration companies will never sully the deep sky. Prior to modern scientific explanations of the events of the natural world, humans looked to the night sky for manifestations of spiritual yearnings, echoes of which reverberate in modern society in the traditions of religious faiths, as well as in the ever-popular daily horoscope columns. None of these reasons explain why an astronomer would look to the sky with visions of fast food in mind though. Such is the case, however, if you try to see NGC 7026 [RA = $21^h\ 6.3^m$, DEC = +47° 51´], a planetary nebula that goes by the moniker of the "Cheeseburger Nebula."

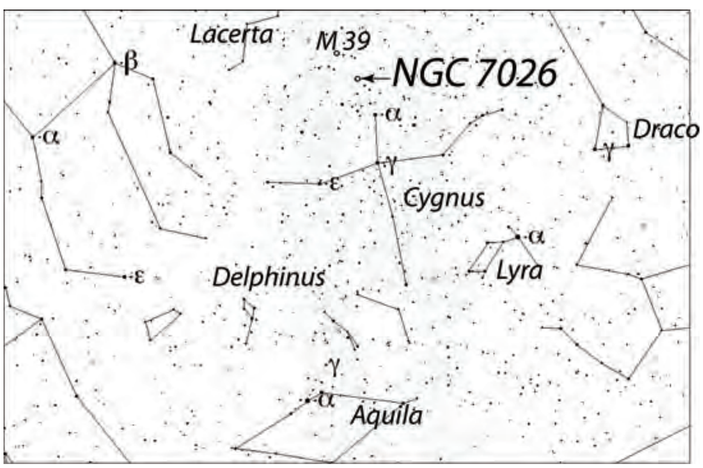

Figure 1 — Position of NGC 7026 in the night sky.

Culinary connotations aside, the shape of a planetary nebula depends on how its nucleus throws out mass into its surroundings, so that a wide variety of shapes is possible. For those with larger telescopes that are able to go to high power, NGC 7026 is one of the most interestingly shaped planetary nebulae in Cygnus. It is about 15,000 years old, and is a little more than 6000 light years away. Don't look at NGC 7026 when you are hungry though, since it actually bears an uncanny

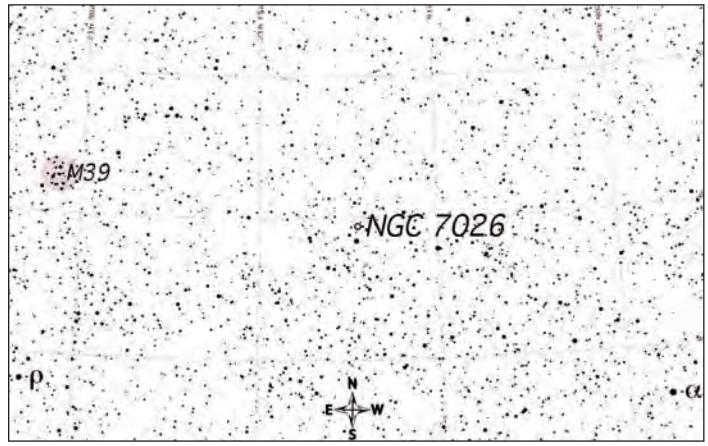

Figure 2 — Finder chart for NGC 7026.

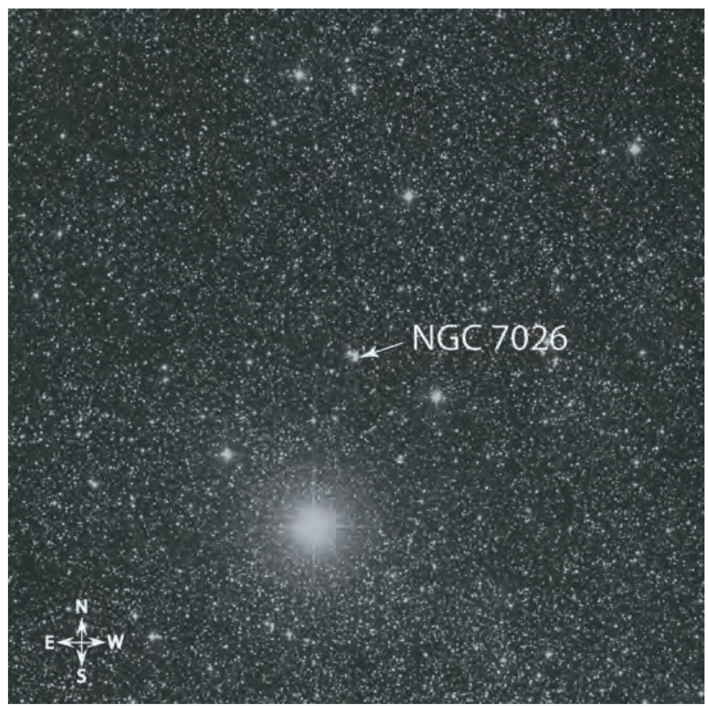

Figure 3 — 50´×50´ POSS image of the field that includes NGC 7026.

resemblance to its informal name. In a 12.5-inch scope at the Saskatchewan Summer Star Party, this was an awesome object at 476×. Its two lobes (the buns of the cheeseburger) were just

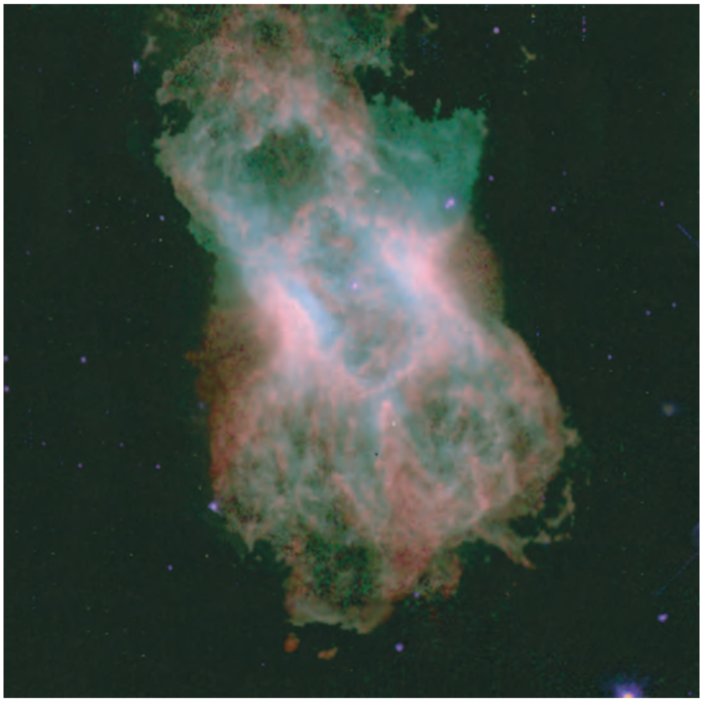

Figure 4 — Image of NGC 7026 from *Hubble Space Telescope* Wide Field Planetary Camera 2.

barely separated by a dark lane (the burger) that came and went with the seeing. The buns are actually an elongated toroidal region that forced much of the mass of this nebula to flow out between them, resulting in a bipolar shape (like M27) in professional telescopes.

The central star responsible for this nebula is now a Wolf-Rayet star, characterized by broad He, C, and O emission lines in its spectrum. It has a mass of 0.6 Suns, a magnitude of 14.2, and a temperature of 80,000 K. About 10% of planetary nebula central stars are Wolf-Rayet stars.

One of us had hoped to convince several observing friends to take a snack break after showing them this nebula, but to our stomach's dismay, the resemblance to a cheeseburger was apparently not good enough to invoke a food-craving response. We encourage you to find this nebula and see if you have better gastronomical luck.

Warren Finlay is the author of Concise Catalog of Deep-Sky Objects: Astrophysical Information for 500 Galaxies, Clusters and Nebulae *(Springer, 2003), and is a professor of Engineering at the University of Alberta. Doug Hube is a professional astronomer actively retired from the University of Alberta, and Associate Editor of this Journal.*

Through My Eyepiece

Starting Out: Sketching at the Eyepiece

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

On Saturday, 1957 October 5, I climbed the steps behind McGill's Molson Stadium and made my first visit to the Montreal Centre's observatory. The day before had been a momentous day in history: the Soviet Union had announced the launch of *Sputnik*, the first man-made satellite, and AVRO rolled out the prototype of the next generation of Canadian aircraft, the ill-fated Arrow. In retrospect, those events vanish in comparison to the universe of astronomy that opened to me that night.

Of all the astronomical techniques I learned over the next seven years in that building, the one that has proved to have the greatest long-term value was learning to make simple sketches of what I saw through the eyepiece. Not only do these sketches serve as an aid to my memory in recalling things I have observed, but the very act of committing subtle features to paper increases the power of the human eye to see detail at the limits of perception.

When the idea of trying to draw what I was looking at was first suggested to me by Isabel Williamson and George Wedge, I couldn't accept what they were asking me to do. I had never made a drawing in my life, and had absolutely no artistic talent. However, the way they presented astronomical drawing to me was that there was no artistic component whatsoever: I would merely be copying what I saw at the eyepiece as accurately as I could. I practiced at first by copying drawings of astronomical objects I found in books and magazines. I then tried sketching a picture of Mars on the far side of my bedroom. Finally, I tried doing the same thing at the eyepiece.

The tools I used were very simple. Ordinary paper, a softish pencil (2B works well), a good-quality eraser, and, most important of all, something called an "artist's stump." You can buy a stump at any art supply store for a dollar or two: it is a pencil-shaped roll of blotting paper sharpened to a point. This simple tool is the secret that allows an artistic incompetent like myself to produce realistic drawings.

Figure 1 is one of my earliest lunar drawings, made on 1959 May 18/19 with my 8-inch Cave Newtonian at 360×. One of the first things I learned was that most drawings of the Moon and planets were a race against time: your subjects are moving and rotating, with sunlight illuminating the surface at continuously changing angles. Capturing an image before it changes too much for a representative sketch can't take more than 15 or 20 minutes. You can't draw the whole Moon in

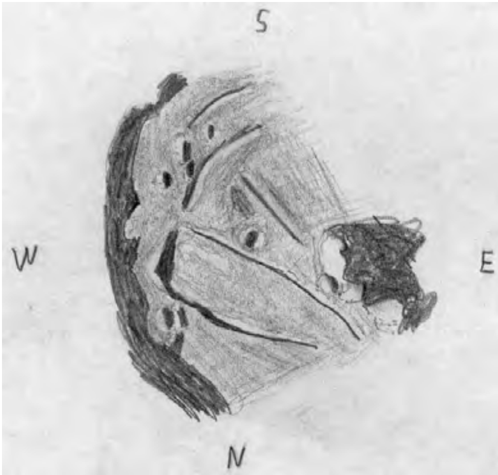

Figure 1

that time; you can't even draw a typical large crater. So I learned to draw the portions of a crater that interested me — in this case the hills and rilles between the central peak and eastern wall of Gassendi. I made no attempt to draw the central peak in detail, nor the eastern wall.

Do you notice anything peculiar about Figure 1? It was made with a Newtonian, so is an inverted image, but the eastern wall is labelled "W" for "west." The drawing was made in 1959, a decade before humans walked on the Moon. The convention at the time was to label directions on other bodies as they appeared in our sky, with east towards the Earth's eastern horizon and west towards our western horizon. Two years after this drawing was made, the IAU adopted the "astronautic convention," whereby directions on the Moon and planets were labelled as they would appear to someone standing on that object, not viewing it from the Earth.

If you look closely at this drawing, you may be able to identify the techniques that I used. First I copied the shadows, drawing them just as simple blocks of black. This provided a frame of reference for the rest of the drawing. Then I filled in the floor of the crater with light, even strokes of my 2B pencil. It looked an absolute mess! Then came the magic of the artist's stump. By lightly rubbing its tip over the shading, I smoothed out the pencil lines, blending them together to make a more or less even grey floor for the crater. Then, with a pointed eraser, I picked out the brighter spots, marking them in my drawing in their position relative to the dark shadows. I gradually added more shadows and took away more "floor" to make highlights, all the time copying only what I saw. Suddenly, the whole picture popped into three dimensions!

By concentrating on patterns of light and dark, and not paying much attention to the reality of mountains and craters, ridges and rilles, somehow they all became more realistic. I also noticed little wrinkles in the floor, darker patches, and highlights I would never have seen if I'd just been staring passively. Try it...it works!

Figure 2 is a more recent drawing of Mars, made on 2003 July 5 during the wonderfully close apparition of that year. I used my 11-inch Starmaster Newtonian with 300× eyepieces in a binoviewer. The image was drawn seven weeks before opposition on August 27, and so the planet shows a strongly gibbous disk. This was the first thing I drew, to get the proportions right. Once that was out of the way, the race against time began, as Mars rotates relentlessly from right to left in this image. The first surface feature drawn was the

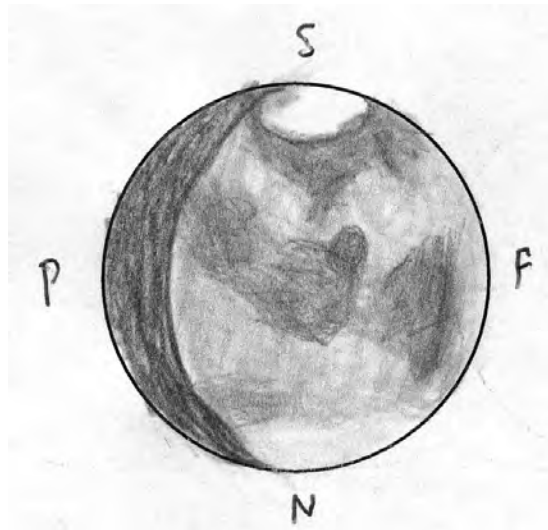

Figure 2

south polar cap, followed immediately by the north polar hood — the cloudy haze at the bottom of the disk — as both were little affected by Mars's rotation. I followed these two by sketching in the markings in the centre of the disk, recording the moment as the "official" time of the drawing. With these more obvious markings as a frame of reference, I then filled in the finer details — brief glimpses of dusky shadings at the very limits of perception — as the seeing permitted. Adding them to the sketch made them clearer in the eyepiece, and gradually a complete picture was assembled. All of this was done with light strokes of my 2B pencil.

At the very end, I went to work with my artist's stump, smoothing away the pencil lines and restoring the vagueness that I actually saw at the eyepiece. In all, I took about an hour to make this drawing, but the crucial details were laid down at 09:03 UT on July 5, and that's the time I used to calculate the central meridian (233°) for the drawing.

With some very simple tools (the only thing you'll probably have to buy is an artist's stump), a lot of practice on stationary objects to learn some simple techniques, and an ability to capture the essential detail quickly and accurately, just about anyone can learn to record the view at the eyepiece. Most important of all, more than anything else you may do in astronomy, drawing will teach you to *see*, and that's what it's all about.

Geoff Gaherty is currently celebrating his 50th anniversary as an amateur astronomer. Despite cold in the winter and mosquitoes in the summer, he still manages to pursue a variety of observations, particularly of Jupiter and variable stars. Though technically retired as a computer consultant, he's now getting paid to do astronomy, providing content and technical support for Starry Night Software.

Doing Time on the 72!

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

It isn't often that amateur astronomers get to use really big telescopes, and although the Plaskett telescope at the Dominion Astrophysical Observatory near Victoria, B.C. is no longer big to professionals, it is significantly larger than anything I have ever used. From April 26 to May 3 of this year, I was fortunate enough to do some first-hand research on this telescope courtesy of an NSERC research grant that Dr. Gord Sarty of the University of Saskatchewan was able to secure.

Figure 1 — The author stands beneath the McKeller spectrograph on the Plaskett telescope.

The 42-ton, 1.82-metre (72-inch) diameter, 15-metre-long Plaskett telescope was once almost the largest telescope in the world. The telescope was conceived and mostly designed by Canadian astronomer John S. Plaskett. The original plate-glass mirror was ground and figured by John Brashear in Pittsburgh (it now sits in the visitor's centre, having been replaced by a ceramic mirror in recent times). Completed in 1918, the telescope out-sized the 1.52-metre (60-inch) telescopes at Harvard University and Mount Wilson but lost the title as *World's Largest Telescope* (tying the Lord Rosse telescope) by only a few months, being scooped for first light by the 2.5-metre (100-inch) Hooker telescope at Mount Wilson.

In its prime, the telescope was used by Plaskett to measure stellar radial velocities. These were used in turn to study star masses and motions about the Milky Way. Plaskett worked on star streaming and interstellar matter, refining knowledge of the Solar System's motion around the galaxy and the size of the Milky Way. In 1922, he discovered the most massive star then known, V640 Mon, now nicknamed "Plaskett's Star." V640 Mon has only recently given up its first-world ranking but remains an astonishing double star with O7.5 I and O6 I companions of 42.2 and 51.0 times the mass of the sun! (Linder *et al.* 2006) These days, the telescope does a lot of photometry and spectroscopy of variable stars, comets, asteroids, quasars, and local galaxies.

To complement the Plaskett scope, the DAO also runs a 1.22-metre (51-inch) 1961-vintage English-built telescope that was modified for spectrographic work once it was moved to the mountaintop. It mostly studies the orbits of binary stars. The other telescope on the hill, a torque-mounted 0.41-metre (16-inch) Boller and Chivens telescope, was built in the 1970s for site testing for Canada's New National Observatory, spending much of its youth at the top of Mount Kobau, B.C., until Canada decided to partner up and build the Canada-France-Hawaii Telescope instead. The telescope was moved to the DAO in 1981, used for research on molecular clouds in the Milky Way for a while, and then moved once again to a new location on the mountain and incorporated into the *Centre of the Universe* visitor's centre. The entire facility is run by the Herzberg Institute for Astrophysics (HIA), which also has their offices on the mountain.

Gord arrived on Little Saanich Mountain a few days before I did. He had used up a lot of his away-from-home family credits visiting the AAT (Anglo-Australian Telescope) in Australia and decided that he had better get a research assistant for this trip. We had begun doing a joint research program on High-Mass X-ray Binaries (HMXBs) over a year ago, and the purpose of this trip was to obtain spectra at different points in each star's orbit. I was already doing multi-band BVRI photometry on these stars to support his on-going program, and he asked me to take over the DAO run so he didn't have to be away so long. I jumped at the chance.

The observatory is only a 2.5-hour flight from Saskatoon, so access is really only limited by the availability of travel funds and whether or not one can get away from the more mundane tasks of life, such as a day job. (Canada provides free telescope time to researchers if their proposals are accepted.) The taxi ride from the airport reminded me that winter was not as harsh here as it was at home. The grass was green, and trees were flowering. Home still had residual snow piles! Twenty minutes after landing, we were at the gate of the observatory; after negotiating the winding road up to the maintenance building, I was given a master key. They welcome you and then assume that, as a researcher, you know what you are doing. That key gets you into all of the domes and the dormitory. Now that's power! Site electrician Marilyn Bell gave me a ride up to the visitor's dorm, which was tucked away around back in a quiet part of the site.

Dormitory facilities are very good here. You have your choice of the *White House* (the original office and residence) or a smaller, more secluded dorm. We chose the latter. Like the rest of the facility, use of the dorms is free, and all you have to supply is your own food. The dorm has five individual bedrooms for visiting astronomers, a living room with a TV and telephone, a communal shower (with only room for one at a time!), washroom, and a full kitchen complete with stove, fridge, microwave, pots and pans, dishes, and a whole bunch of old food and spices (some moldy, but most not) left from previous visitors. It looked a lot like my place, only cleaner, so it would make a very nice home-away-from-home for the next week. When I arrived at 8:00 a.m., I found Gord fast asleep, after having pulled an all-night session up on the scope.

Once Gordon got up at about 2:00 p.m., we had our bowls of breakfast cereal and walked up to the big dome. Site technician Dymitry Monin was already tinkering with the telescope, catching up on routine maintenance. When Gord attended the last Canadian Astronomical Society/Societe Canadienne Astronomie (CASCA) meeting, he met Dymitry, and through that meeting, was attracted to the DAO. Coincidently, Dymitry and Gord went to the same high school in Moncton, New Brunswick, though at different times. Dymitry's job was to keep the telescope working, make sure that the spectrometer band was correctly set up according to our observing request, and to train new operators. Dymitry had already trained Gord on the telescope operation, and on the first afternoon, Gord trained me. Later in the week, Diane Luciuk, one of Gordon's summer students, joined us to help out as well.

The routine here is pretty basic. You have telescope time from sundown to sunup, so you might as well get into the right sleep pattern to start. You get to bed about 5:30 a.m., sleep until noon, have breakfast, laze around or do some sightseeing, have supper about 6:30 p.m., then get back to the dome for the next run by 8:00 p.m. The sooner you convert to the out-of-sync routine, the better you feel during the days and nights up here. We found that it was much easier just to concede to the new cycle, so even if it was cloudy, we spent the night awake in the dome, and slept until noon the next day. The dome control room also has a good kitchen, so snacks, midnight lunch, and coffee were all at hand.

Quite frankly, running the telescope is easy, and far easier than running the 12-inch scopes using *MaximDL* software on the physics roof back home. Not that I have anything against *MaximDL;* it is a wonderful program, but it has to do everything for everybody! The Plaskett telescope control system does not have to do anything but control the telescope and get images from one fixed instrument. So learning the ropes and assuring that I didn't bang into any dome obstructions with the telescope only took a few hours and one nervous practice run, with a sweaty finger placed near the big red button, just in case.

Once the training was done, we spent some time exploring the *Centre of the Universe* visitor's centre. They have a great set of interactive displays on all aspects of astronomy, with a special

Figure 2 — Safety first! Liquid nitrogen at -110 °C needs to be poured into the Dewar every four hours to keep the CCD camera at operating temperature. We may have been the last observers to do this since they were busy installing a continuous LN_2 circulating system.

emphasis on Canadian programmes and observatories. The Centre has a fairly steady flow of school groups and a constant trickle of visitors to keep the two full-time interpreters busy. Especially welcome was the unexpected arrival of members of the RASC Victoria Centre for a public starnight on Saturday evening, despite thick haze. We got to visit a bit and swap Centre stories. Little Saanich Mountain is also a nature preserve, so we could go hiking along the many trails to kill the afternoons and evenings. Being in a coastal rainforest has its advantages. The mountain is very green, with many varieties of trees, mushrooms, mosses, birds, deer, and free-range naturalists.

The first real night of observing was the test of how well my travel-weary brain remembered the day's training session. I arrived at the dome an hour before dark, donned safety protection equipment that made me look like Darth Vader, and filled the CCD camera Dewar on the McKellar spectrograph with liquid nitrogen (LN_2). It takes the CCD camera about an hour to reach operating temperature of -110 °C. At this temperature dark frames are not required as there is basically no electronic noise — the dark current is less than one electron per hour. The operator has to shoot only a few bias frames, which can be done anytime during a run and then be used for the entire week.

Around the corner in the control room, I pulled out the emergency stop (E-stop) button, hit reset on the control computer, and the telescope started up. Returning to the dome, I used a remote control similar to a garage door opener to open the massive dome shutters and move back the windscreen. A flip of a switch on the telescope opened the mirror cover. You remember to do this in the very same order, and do the exact opposite when closing, to minimize the chances of anything falling on the mirror's surface. They frown on anything other than starlight striking the mirror's surface! Back in the control room, five monitors stared me in the face, but each had a specific job, and the whole thing was easy to understand. From a well-designed graphical user interface (GUI), I could double-click the target object from a menu Gord had previously installed, and, *viola!* the dome would move to the correct spot, more or less. The telescope started tracking too, but to prevent slewing the huge spectrometer into the pier or driving the front end into a dome obstruction, I had to walk out into the dome and push the North button to get a fast slew. Taking your finger off the button stops the telescope, but just in case, there was also a big red E-stop button on the paddle! Although the telescope has programmed "keep-out areas," this does not preclude anyone leaving a ladder or other piece of equipment somewhere where I could hit it. When pointing at some areas of the sky, the spectrograph cleared the floor or the concrete pier by a mere seven centimetres — 'way too close for my comfort zone!

With the telescope pointed at the object, I returned to the control room, clicked the user interface to change the viewing diaphragm aperture to "solid" (clear aperture), and with any luck the target would be seen by the image-plane video camera. A few minutes of tweaking the position using the arrow keys on the older tracking computer, and the object was centred. Since we were doing spectroscopy, I flipped to the spectrograph slit, zoomed in the camera, focussed a bit, and bisected the image of the star on the slit until it looked like a small dumbbell.

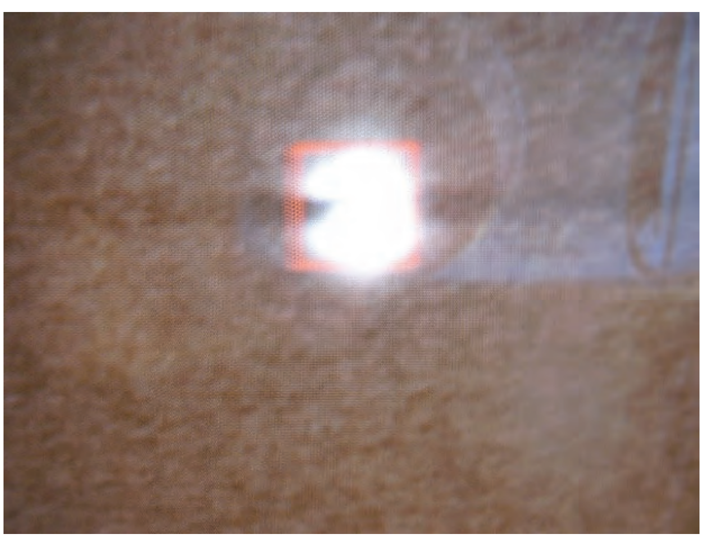

Figure 3 — No — this is not NGC 5128! A fuzzy dumbbell-shaped image of the target star is what spectroscopists dream of! Spectroscopists have a strange sense of achievement!

With spectroscopy, you are trying to see emission and absorption lines in the spectrum. Because every new set-up was very slightly different, you could not just take the image and expect to know the exact identity and position of each spectral line. All the CCD gives you is a pixel number for the line on the image, so to get useful data, you also have to obtain a reference spectrum. In the spectral band that we selected, we used an iron-argon arc lamp that provided spectral lines at precisely known wavelengths, which we would later use to calibrate our spectra. Because we were working at high dispersion, hoping to see movements in our stellar systems as small as one kilometre per second, we needed very accurate references.

For each target star, our procedure was to turn the arc lamp on, shoot a 15-second exposure, turn the arc off, shoot a 10- to 15-minute exposure of the target-star spectrum, turn the lamp back on, shoot another comparison, then remember to turn the arc off. This last step was important because failure to turn off the arc lamp when shooting the next target resulted in a very over-exposed arc-lamp image! Each star followed the same procedure. Arcs had to be shot to bracket each target because minute but detectible flexures in the telescope and spectrometer would place the image in slightly different locations on the image plane every time. I also had to keep an eye on the Dewar temperature. Each fill of LN_2 cooled the CCD camera for only about four hours, so I'd have to stop what I was doing, park the telescope to its upright position, fill the Dewar, then slew the telescope back to the next target. Forgetting to fill the Dewar would be disastrous since a warm camera produces noisy data, and I would lose a lot of time waiting for the camera to re-cool. Each image displays on the image monitor, and I could review these and adjust exposures as need be.

Oh! Did I say that being in a coastal rainforest has its advantages? *No — it really does not. I changed my mind*. Our hope was to get ten nights of spectra for each of the four stars in our program, plus a set of radial-velocity reference-star spectra over the observing run. However, Mother Nature was not a good companion for astronomers, especially at this time of the year. We had near-constant cloud cover and were able to shoot for only parts of three evenings during the week-long run. Even those nights were not that clear. However, spectroscopy is not as sensitive to cirrus cloud as full-frame imaging or photometry, so despite the poorer skies, we obtained good, useful spectra.

At the same time that we were collecting our data, we coordinated with the American Association of Variable Star Observers (AAVSO) to get overlapping V- and I-band CCD time-series photometry. In the end, a handful of AAVSO observers obtained a lot of great data for us. To help orchestrate each night's run, I'd log onto the AAVSO chat group, where observers often hang out, to coordinate observing coverage.

However, chalk up the week as a valuable learning experience. Despite obtaining far less data that we had anticipated, the overall cost was pretty small, and now we have three trained operators who can return to do follow-on research. In the wee hours of the morning, we had a tonne of spare time to dream about training a legion of amateur researchers to use the telescope and make efficient use of the facility for a wealth of future research opportunities.

I am indebted to Gord for the opportunity to work at a large, professional telescope — an experience that translates into a much-improved understanding of the work I have been doing on the roof the physics building at the University of Saskatchewan, though the scopes sure look like tiny babies by comparison to the Plaskett!

Figure 4 — The Dominion Astrophysical Observatory is at the top of Little Saanich Mountain, just outside of Victoria, B.C. The surrounding lands are a nature preserve full of coastal flora and fauna.

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More Reading

Sarty, G., Kiss, L., Johnston, H., Huziak, R., Wu, K. 2007: Finding Periods in High-Mass X-ray Binaries, *JAAVSO* (available at www.aavso.org/publications/ejaavso/ej56.pdf)

Florence, Ronald 1995, *The Perfect Machine: Building the Palomar Telescope* (Perennial Library Publishers, New York) ISBN 0060926708

Richard Huziak is a researching amateur astronomer who would now love to have a 1.82-metre scope in his backyard. Could a surplus satellite dish and some really smooth tin-foil work? Hmmm...he wonders?

Gizmos

The Dew Season

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

This month, and the 11-month period immediately after this, is the dew season in Canada, so it is no wonder that amateur astronomers are creative when it comes to making dew shields. In fact, there aren't too many materials out there that have not at some time been rolled into a cylinder and stuck on a telescope. Dew shields have been made of paper, plastic, metal, cardboard, foam, felt, and fabric with varying degrees of success. What they almost all have in common is that they are made of flat material rolled into a tube, and they won't stay round, and the corners won't lie flat.

My best answer so far is a two-litre soft-drink bottle. Pull one of these out of the recycling bin and take a look. Cut away the top and bottom and what's left? A dew shield, of course. What's more, a dew shield that was made round and wants to stay that way. Cut it down its length and the sides overlap to fit any scope up to about 90-mm. For bigger scopes, look for bigger bottles. A 5-litre bleach bottle will do a scope up to 150-mm. After that there are fewer options, but I have been eyeing that big blue jug inverted on top of the water cooler.

Whatever you use, remember...start round, stay round. Put it on your scope and wrap an elastic band around it; and when you're done, it wraps up tightly and stores in a mailing tube.

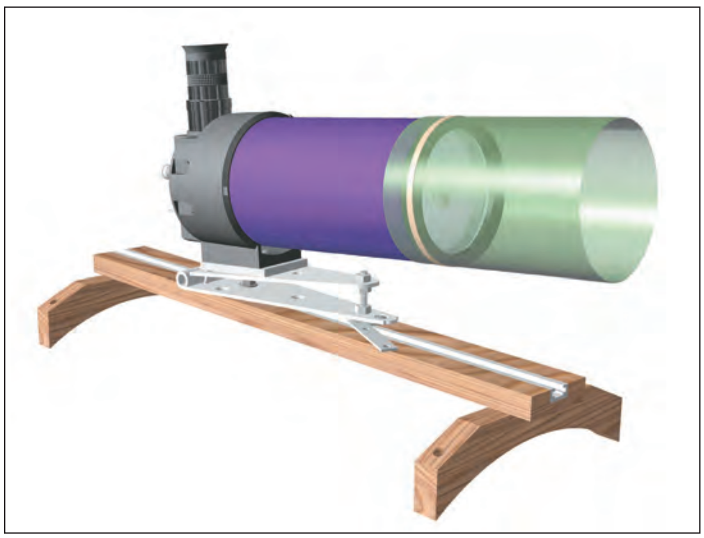

Figure 1 — The dew shield is held in place with an elastic band. It stores by sliding it down the tube or it can be removed and rolled small. The x/y mount was described in the August issue.

Don Van Akker is a member of the Victoria chapter. He's interested in your ideas for future articles and can be reached at don@knappett.com.

Crescent Conjunction

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

Everything makes sense
after work, after dark
It's a graceful silence
I'm just sad I can't stay
and roll the stars each night
and roll the stars

— Jorane, *"Roll the Stars"*

Planetary conjunctions are among my favourite events in astronomy. I try to catch every one that I can — I've even been known to set the (gasp) alarm to chase them. I have observed dozens of conjunctions over the years, including a fair number where two planets were comfortably visible in the same telescopic field of view. After being clouded out for last December's rare telescopic trio involving Mercury, Mars, and Jupiter, I was more fortunate for this summer's splendid Venus-Saturn conjunction.

The circumstances were almost ideal: it was three weeks after Venus's maximum evening elongation, during which time the inner planet's apparent motion had been primarily Earthward, its apparent disk size growing and its phase diminishing into a pleasing crescent. Its elongation was still a comfortable 43°, so Saturn was not yet engulfed in the evening twilight that would overwhelm the ringed planet a few weeks later.

I caught an extended view of the pair at closest approach, about 40 arcminutes apart, on the evening of June 30. It was a rare opportunity to do some serious observing while attending the RASC General Assembly. Fortunately the affable Ed Wozney and Garry Barton of the host Calgary Centre set up telescopes for public viewing of this unusual spectacle, which looked particularly fine in Ed's 110-mm refractor. Back home in Edmonton two nights later, I had another long look through our local observatory's 100-mm Zeiss Jena refractor and 180-mm Astrophysics Starfire refractor, when the pair were still within about 1.25°. On both occasions I considered this conjunction to be one of *exceptional* beauty.

Venus dominated the view, being far brighter and giving the illusion of being much larger. While there's no doubt that Saturn was dimmer — by a factor of 100! — upon careful observation, the area of its illuminated surface was actually very similar to that of Venus. The inferior planet clearly displayed the larger apparent disk, but only a fraction of it was actually visible: the dimensions of 35%-illuminated Venus were 31″ long by only 10″ wide, while in Saturn's case the full disk of polar diameter 15″ was the *narrow* axis, with the rings stretching some 36″ in extent. In terms of illuminated surface area, therefore, Saturn was greater in both dimensions. While the two shapes involved were decidedly different, a rough calculation indicated that the illuminated portion of both was almost the same, about 275 square arcseconds (see Figure 1).

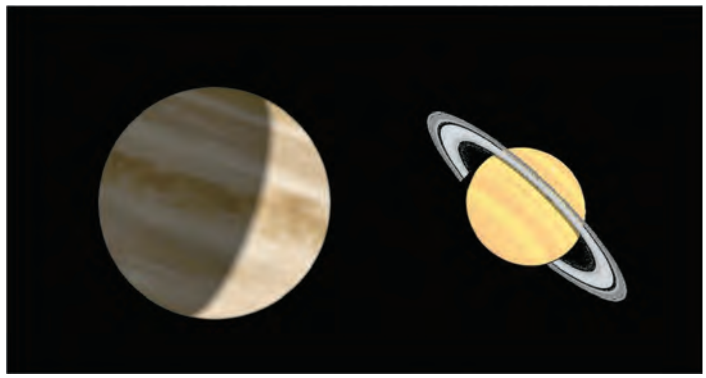

Figure 1: Venus and Saturn as they appeared on 2007 June 30. While the comparative sizes of the planets are to scale, they were separated by over 40´, or about 80 times the long axis of Venus. The high surface brightness of Venus is muted in this *Guide 7* simulation, which makes it easier to see that the illuminated areas of the two are similar in scale, if very different in shape.

Especially striking about this particular duo were the disparate shapes of the two, an aesthetically pleasing crescent paired with one-of-a-kind Saturn. Usually one or both components of a conjunction is a simple disk. In this case the juxtaposition of the brilliant crescent of Venus against the dim but fully illuminated Saturn provided irrefutable evidence of the Sun's position between the two, considerably closer to the former. While at the eyepiece I was particularly struck by the crescent appearance of Venus, and couldn't recall observing it during *any* of my previous experiences involving Venus and another planet. This got me thinking (always a dangerous prospect). Is crescent-Venus-in-conjunction really a rare observation, and if so, why?

In short: yes, it's rare. For my first rough calculation I omitted such matters as Schröter's Effect and "when does a crescent look like a crescent?" and simply considered the interval between eastern and western elongations to be the crescent phase. In a given synodic period of ~584 days, Venus speeds from evening to morning elongation in ~142 days, making the return trip around the far side of the Sun in a much more leisurely ~442 days. So it is gibbous for over 75% of each synodic cycle.

Moreover, during the time of Venus's crescent phase, the Sun advances about 140° eastward against the background sky, but Venus's own progress is only about a third of that, as it moves over 90° *westward* with respect to the Sun. Therefore it is much more unlikely to overtake a distant outer planet during this portion of its orbit. Whereas during its gibbous/full stage, that 90+° of Venus's motion from western back to eastern elongation is *added* to that of the Sun, so during those 442 days the inferior planet moves some 525° against the background sky. It would seem that Venus is about ten times less likely to overtake a distant target when in its crescent stage.

But that only applies to a stationary target. We must also consider the motion of Saturn itself against the stars. At about 12° per year, this seems relatively inconsequential, but all of that and more occurs when Saturn is within ~45° of the Sun and therefore within the range of Venus! In the ~140 days surrounding its own conjunction with the Sun, Saturn covers over 15°, its steady eastward progress uninterrupted by the retrograde motion that will dominate the opposition portion of its synodic period.

Add it all up and Venus's mean progress with respect to Saturn is ~1.1° per day during its gibbous stage, and slightly more than 0.2° per day during its crescent stage. Since the former is also >3 times the duration of the latter, it follows that Venus is about *15 times* as likely to overtake Saturn while gibbous than while crescent.

The "good news" is that given Venus's retrograde motion around the time of its inferior conjunction — in 2007 it was stationary (although dropping like a stone) on July 25, then regressed some 16° until its second stationary point on Sept. 7 — its crescent encounters with Saturn often take the form of a triple conjunction. The "bad news" is that when in proximity to Earth, Venus's inclination to the ecliptic is highly exaggerated, making it far *less* likely to have a close conjunction where both bodies can be seen in the same telescopic field of view. In the current sequence, Venus came within 0.7° of Saturn during its first conjunction on July 1, but passed a whopping 8.7° south of the Ringed Wonder on August 13, and will be nearly 3° away on Oct 14 (see Figure 2).

The two editions of Jean Meeus's *Astronomical Tables of the Sun, Moon, and Planets* (1983, 1995) list all planetary conjunctions in right ascension from 1976 to 2020. In the last triple conjunction between Venus and Saturn back in 1989/90, the *closest* of the three was almost 4° in separation. The other 41 events listed were/will be single conjunctions, and a quick comparison of the dates to those of Venus's inferior conjunction confirmed that all 41 occured during Venus's gibbous phase.

I initiated a correspondence on crescent-Venus conjunctions with Dr. Meeus, an RASC honorary member and a most accommodating man. I knew Jean would be interested due to

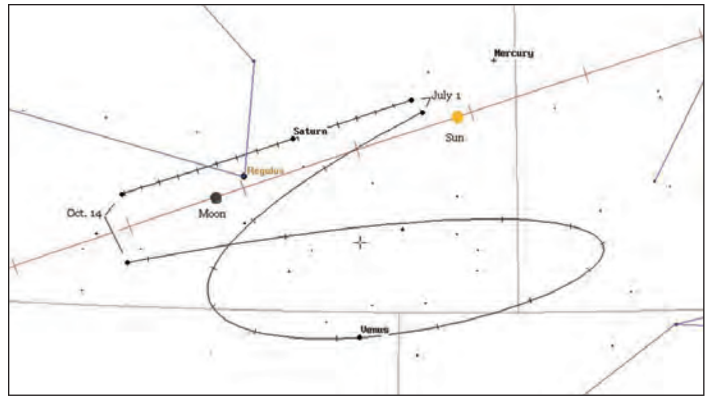

Figure 2 — The divergent paths of Venus and Saturn during the triple conjunction of 2007. The first conjunction occurred at the beginning (right end) of the displayed paths about three weeks after Venus achieved greatest evening elongation, and the last at their left end will be about two weeks prior to greatest morning elongation. The position of both planets (as well as of the Sun, Moon, and Mercury) is shown as of the central, very wide conjunction on August 13, just a few days before Venus and Saturn respectively achieved inferior and superior conjunction with the Sun and near the very bottom of Venus's retrograde loop. Over the 15 weeks of the triple conjunction, both planets progress about 13° against the background sky, while the Sun rolls against the stars more than 100° in the same time.

our previous collaboration on conjunctions between Venus and Jupiter, in which triple conjunctions play a critical role. (Meeus 2007) It hadn't occurred to either of us to consider the actual appearance of the inferior planet during such encounters. As Jorane sings, sometimes everything makes sense only after dark, with an eye to the sky and a mind set to "hmmm" mode.

Sure enough, upon my request Jean tweaked his conjunction program to calculate the illuminated fraction of Venus during each encounter with an outer planet, then sent me 1000 years' worth of data! Concentrating on the period 1800 to 2200, we found a total of 416 conjunctions in longitude between Venus and Saturn; 54 of these are crescent events, including 15 triple conjunctions and 9 singles, or just 24 occasions where Venus overtakes Saturn while in the crescent phase. The remaining 362 conjunctions, all single, involve gibbous Venus. The distribution of 362/24 conforms almost exactly to the 15:1 ratio calculated above. Sometimes the ol' back-of-the-envelope method works just fine!

Future prospects of seeing crescent Venus in the same telescopic field of view as ringed Saturn are extremely limited (see Table 1). The lone (marginal) opportunity this century occurs on 2042 December 23, when a 47% thick morning crescent will pass 0°56′ from Saturn. Mark your calendar!

If you don't want to wait that long, the immediately upcoming conjunction in the week or so centred on October 14 is good in many respects for northern latitudes. While the two objects will be 3° apart at best, they are very favourably placed in the morning sky, far to the northwest of the rising Sun, and nearing 30° altitude at nautical twilight. Venus will be within a degree of its maximum elongation of 46°, which occurs two weeks later, but will still display a noticeable crescent at 42%. The two planets will once again be very similar in their illuminated areas, although it will be necessary to slew your scope a short distance from one to the other. In steadily held or mounted binoculars it should be possible to see that both objects are out-of-round.

Opportunities to see crescent Venus in close conjunction with other outer planets are similarly rare. For Jupiter, there are also just two opportunities this century; by far the better will occur on 2015 July 1, when the two will be just 21′ apart. Coincidentally, this will be eight years to the day after this year's fine Venus-Saturn event, so Venus with its ~8.0-year period will be in very nearly the same place in Earth's sky, at similar favourable elongation (42° E) and phase (34%).

For Mars the situation is bleaker. Only once in this century (2060) does crescent Venus come within 1.5° of the Red Planet, and observation of the latter will be virtually impossible just 13° from the Sun.

I must stress that there will be other opportunities to see close conjunctions involving *gibbous* Venus, such as that upcoming on 2008 February 1, when Jupiter comes within 0.6° of the 85%-illuminated terrestrial planet very low in morning twilight. While such opportunities are more numerous, good ones are still relatively rare as Venus never strays far from bright twilight, which often overwhelms her more remote dance partner.

TABLE 1.

Date	$\Delta\beta$	Elong.	k
2007 Jul. 01	**0°41′**	**43° E**	**0.352**
2007 Aug. 13	8°44′	11° E	0.015
2007 Oct. 14	2°54′	46° W	0.421
2025 Jan. 19	2°11′	47° E	0.462
2025 Apr. 07	7°51′	23° W	0.082
2025 Apr. 25	4°08′	38° W	0.239
2042 Dec. 23	**0°56′**	**47° W**	**0.468**
2060 Apr. 06	6°26′	44° E	0.359
2060 May 18	4°49′	8° E	0.010
2060 Jul. 20	2°18′	45° W	0.429
2078 Feb. 23	3°10′	47° W	0.457
2098 Aug. 05	3°35′	45° E	0.419
2098 Oct. 08	9°32′	12° W	0.021
2098 Nov. 15	1°57′	43° W	0.328

Table 1 — Conjunctions of Saturn with crescent Venus, 2000-2100, courtesy Jean Meeus (2007, private correspondence). Windows of opportunity occur at regular intervals of about 17.6 years, or 11 synodic periods of Venus to 17 of Saturn, with occasional corrections of ±3.2 years, as in 2098. These encounters can take the form of triple conjunctions, as in 2007; or single conjunctions very near Venus's maximum elongation, as in 2042, in which case Venus's phase, *k,* is very close to 50% illuminated. Of 14 such conjunctions in the current century, just two, shown in **bold**, occur when the 2 planets have a separation ($\Delta\beta$) of less than 1 degree.

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A proof-reader and self-described "logic editor" for the RASC Observer's Handbook *and* Observer's Calendar, *Bruce McCurdy likes to spot observing oddities sufficiently in advance to give his loyal readers the heads-up. Sometimes, however, observation comes first, prompting later theory and the application of fresh logic, as in the current instance.* C'est la vie.

Mysterious Henrietta Revealed

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

I can see clearly now, the rain is gone,
I can see all obstacles in my way
Gone are the dark clouds that had me blind

(c) 1972 Johnny Nash

After a very worrisome week full of clouds and thunderstorms, I enjoyed nearly perfect skies on Sunday evening, 2007 August 15, for the occultation of a tenth-magnitude star in Aquila by asteroid (225) Henrietta. A few nights earlier, during a break in the cloud cover, I tracked down the target star (TYC 1065-00745-1) with my 12.5-inch Newtonian telescope and installed my low-light-sensitive "surveillance" video camera, GPS-driven video time-insertion device (that puts a running clock on the screen), and VCR/TV combination unit. Then I left everything in place and shut down the observatory to wait for Sunday night. For the rest of the week, nearly continuous cloud and at least one electrical storm every afternoon kept the observatory closed and deserted on the hill behind my cottage in eastern Ontario. Sunday was no better until early evening when, after yet another shower, the clouds began to break up and I allowed my optimism to come out and play. By 10:00 p.m. it was completely clear. In fact, this turned out to be one of the most transparent and steady nights of the year so far.

The occultation was predicted to begin at 12:45 a.m. EDT (04:45 UTC) Monday morning, but unable to wait, I opened up the observatory at 10:30 p.m., swung the telescope to bear on the target star, and sat back to wait. I'm glad I allowed the extra time, though, because I needed some of it when I discovered that the VCR failed to record a routine test. Oh-oh! Try again. Same thing. Could the tape be defective? I pressed "Eject" to check it out, but the machine, clearly in a snit, kept the tape and turned itself off. Yikes! Try again! I turned it on, pressed "Eject" and stuck my finger in the slot to try to help the cassette make its escape. That worked. A close examination of the tape revealed that one edge was badly chewed up, which was surprising since it was a brand new cassette. So I spooled a few feet past the damaged section and reinserted the cassette in the recorder. Everything went fine after that. (Toronto Centre member Charles Darrow later speculated that humidity could have been the problem. Because I left the VCR exposed in the unheated observatory for several rainy days, the machine likely collected more moisture than it should. Charles is probably right. Lesson learned.)

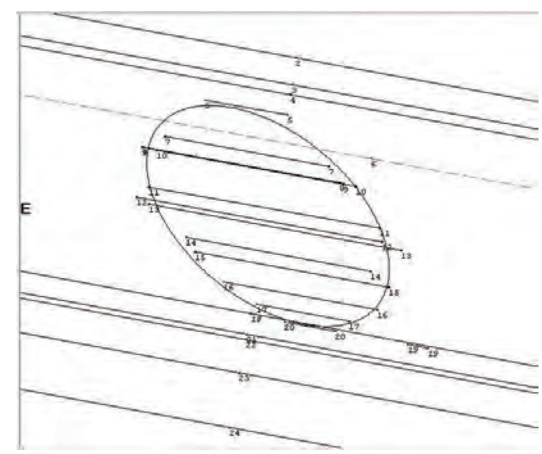


Figure 1 — The best-fit ellipse for asteroid Henrietta from the IOTA Web site. The solid lines across the ellipse show chords for which the various observers detected a decrease in brightness of the target star. Chords for observers who recorded no occultation are also shown as continuous lines outside the ellipse and are indicated by an "M" in the list of observers. Note the interrupted observation by Frank Dempsey shown as chords 19 and 20.

The camera/telescope system registered Henrietta itself, so I enjoyed watching the asteroid slowly approach the target star. Finally, star and asteroid merged into one apparent object with ten minutes to go. Then, at 04:45:42 (UTC), the star disappeared, leaving only the faint (12.5-mag) asteroid visible. At 04:45:58 the star returned. I was surprised that it stayed hidden for 16 seconds, since the predicted maximum duration was 15 seconds and I was close to the southern edge of the predicted path. Clearly, I must have been very near the actual centre line, meaning that the path had shifted southward by about 50 kilometres or so. From my location, the central occultation was scheduled for 04:45:44 EDT, so Henrietta was about six seconds late, too.

This was a very successful night for me, but I was not alone. Far from it, in fact. The event was the best-observed occultation seen from North America so far this year. Scattered from eastern Ontario to southern Nevada, 22 observers, including at least 9 RASC members, have reported their results to IOTA at the time of this writing. Of these, 9 reported misses and one — Frank Dempsey (RASC Toronto Centre) — reported a double occultation!

At first, it was suspected that Frank had observed a grazing occultation of an uneven edge of the asteroid. But I'm not so sure. When a sky-plane plot was generated (Figure 1), Frank's first disappearance-reappearance event seems to have occurred outside the best-fit ellipse. Could he have detected a "satelloid" (satellite of the asteroid)? Perhaps. Further complicating the issue was the observation by Kim Hay (RASC Kingston Centre), who, between Frank's and Rob Macnaughton's (Toronto Centre) "hits," reported a miss! How could this be? If Kim's report is correct, then Frank must have missed the occultation, too. If Frank is right, then Kim could not have missed the event. Both Kim and Frank are very experienced observers, so I hesitate to speculate at this point. For now, the jury is still out, so I'll leave it at that. However, I'll report here if IOTA or ALPO wade into the issue. In the meantime, I hope that for our next occultations, "the rain is gone (so) we can see clearly now." Carpe umbram!

Here is a list of possible occultations over populated parts of Canada for the next two months or so. For more information on events in your area, visit the IOTA Web site, www.asteroidoccultation.com. It is very important that you advise Derek Breit (breit_ideas@hotmail.com) or me (email address above) if you plan to observe and time an event so we can avoid duplicating chords.

DATE (UT) 2007	ASTEROID #	Name	STAR MAG.	Δ-MAG	MAX DUR	PATH
Oct 1	4732	Froeschle	8.4	9.1	1.0	swON
Oct 3	663	Gerlinda	10.6	4.3	8.5	NS-seMB
Oct 6	3227	Hasegawa	9.6	7.2	1.6	sNS, sON
Oct 8	201	Penelope	11.9	1.7	6.2	NL - sAB
Oct 9	2303	Retsina	9.2	7.0	1.7	cMB - sAB
Oct 12	271	Penthesilea	11.9	1.9	5.8	nMB - nBC
Oct 12	6025	Naotosata	10.3	5.2	1.9	sMB - sBC
Oct 17	3786	Yamada	10.3	5.5	7.2	sQC - sON
Oct 19	656	Beagle	9.7	5.1	3.8	nSK - sBC
Oct 21	5090	Wyeth	10.2	5.7	1.2	swBC
Oct 23	585	Bilkis	11.7	3.1	4.1	nON - nBC
Oct 24	731	Sorga	11.3	2.1	3.5	NL - nON
Oct 26	203	Pompeja	10.9	3.4	4.3	sQC - cON
Oct 27	3915	Fukushima	10.3	6.2	2.0	sON
Oct 29	2140	Kemerovo	9.0	5.9	2.6	cON
Nov 3	537	Pauly	11.9	1.7	2.9	nNL - nON
Nov 6	1770	Schlesinger	10.4	5.3	2.3	sMB - nAB
Nov 7	392	Wilhelmina	11.9	2.2	7.9	cON
Nov 8	271	Penthesilea	12.0	1.8	5.9	nMB - seBC
Nov 10	2731	Cucula	10.0	6.5	4.5	nwON - sBC
Nov 11	585	Bilkis	11.5	2.9	7.7	swBC
Nov 12	1325	Inanda	10.4	4.2	1.2	MB
Nov 12	734	Zhongolovich	9.8	5.4	4.0	nwON
Nov 14	869	Mellena	9.4	7.7	1.2	sNL - sON
Nov 16	792	Metcalfia	10.2	3.4	5.4	NS
Nov 18	6827	Wombat	9.3	6.2	1.3	sAB - sBC
Nov 22	4417	Lecar	8.9	7.3	1.9	eNS - sBC
Nov 24	351	Yrsa	9.9	2.8	5.3	sON
Nov 28	1353	Maartje	9.9	6.4	2.8	QC - NS
Nov 29	6905	Miyazaki	10.5	3.9	1.8	swNS - nwBC
Nov 30	792	Metcalfia	11.8	2.0	5.6	sNL - sSK
Dec 6	1633	Chilay	9.4	6.6	1.4	sAB - cBC
Dec 9	105	Artemis	11.5	3.3	16.0	NL - QC

Guy Nason is a long-time member of the RASC Toronto Centre and IOTA (International Occultation Timing Association). He has served the Toronto Centre as Observational Activities Coordinator, Councillor, National Council Representative, Secretary, Vice-President, President, and was, until recently, Past President. He received the RASC Service Award in 2004. He has successfully timed several lunar grazes, total occultations, and eight asteroidal occultations

List of observers

1 (M)	R Royer, Springville, CA
2 (M)	S Messner, Iowa Fall, IA
3 (M)	J Gafford, Deer Trail, CO
4 (M)	D Oesper, Dodgeville, WI
5	P Malley, Last Chance, CO
6	predicted centreline w/time
7	C Peterson, Guffy, CO
8	R Lee, Falcon, CO
9	A Paquette, Carp, ON, Canada
10	G Samolyk, Greenfield, WI
11	G Lyzenga, Jean Dry Lake, NE
12	D Slauson, Swisher, IA
13	G Nason, Gneiss Hill Observatory, ON, Canada
14	L Enright, Sharbot Lake, ON, Canada
15	E Briggs, Toronto, ON, Canada
16	R Wasson, Santa Clarita (Newhall), CA
17	R Mcnaughton, Bolton, ON, Canada
18 (M)	K Hay/K Kell, Yarker, ON, Canada
19	F Dempsey, Greenwood, ON, Canada
20	F Dempsey, Greenwood, ON, Canada
21 (M)	L Luton, Cobourg, ON, Canada
22 (M)	K Kingdon, Kingston, ON, Canada
23 (M)	P Mozel, Oakville, ON, Canada
24 (M)	D Drake, Three Rivers, MI

Evolution of the Meade Ultra Wide Angle Eyepieces

by Gerry Smerchanski, Winnipeg Centre (smirch@mts.net)

Introduction

It should come as no surprise that amateur astronomy undergoes fads and fashions. We might accept this more easily once we realize that science in general, let alone our favourite science of astronomy, has trends and movements that reflect its all-too-human origins. Many trends in amateur astronomy have been driven by technological advancements or economic strategies that led to the production of new and more-capable equipment. One such advance that has added greatly to the visual exploration of the heavens has been the development of wide-field eyepieces that can utilize the expansive fields of view provided by fast-focal-ratio telescopes. Much of this development can be attributed to the efforts of Albert Nagler and his eponymously named line of wide-field eyepieces. For several decades, we have been the beneficiaries of something akin to a "space race," as various manufacturers have endeavoured to produce eyepieces with larger and better-corrected fields of view. Nagler's own company, TeleVue, has produced several generations of its wide-field eyepieces and many articles have been written documenting the improvements and changes — the evolution, if you will — of these optics. However, as in the case of the evolution of species, the mutations are not always in the direction of some notion of perfection, and many variations end up with optical limitations and peculiar characteristics.

This article will look at another, lesser-reviewed line of wide-angle eyepieces that has also undergone a recent evolution. Meade's Ultra Wide Angle Series 4000 (UWA 4000) eyepieces were introduced *circa* 1986 and featured an 8-element, 84° field of view (FOV), an achievement that made them 2 degrees wider than their TeleVue rivals. Putting marketing issues aside, the question arises of just how wide an apparent field of view is useful and desired. I will address this question while reviewing the evolution of the Meade UWAs as they now enter their second generation, called the Ultra Wide Angle Series 5000 (UWA 5000).

The Meade UWA 5000s have fewer elements than their predecessors, reversing a trend in the eyepiece industry, which has seen an ever-increasing complexity in a quest for wider, sharper, fields of view. At times, the optics market appears to have taken its cues from the shaving-razor industry, which hypothesized that by adding an extra blade you could claim superior performance for your razor. In optics, where multiple elements are required to obtain sharp, wide-field views in short-focal-ratio telescopes, there are problems that the razor industry does not have to address. In eyepieces, sometimes less is more. Adding more glass-to-air surfaces causes more light loss and increases the possibility of reflections. In addition, despite the development of modern anti-reflective multi-coatings, adding elements may not be as effective as leaving out the offending element altogether.

Figure 1 — The new 5000 Series Ultra Wide Angle eyepieces and matching case.

The 5000 series has some eyepieces with the same focal lengths as the previous series: 4.7-mm, 6.7-mm, 8.8-mm, and 14-mm. Meade has added eyepieces with new focal lengths not available in the old series: an 18-mm, 24-mm, and a new flagship 30-mm. The 18-mm and smaller focal lengths use a 1.25-inch barrel (Table 1), while the 24-mm and 30-mm employ 2-inch barrels. The new series is completely revamped and is a different optical configuration than the old. All Series 4000 UWAs were 8-element eyepieces with an 84° AFOV. In the Series 5000, the AFOV has been reduced slightly to 82 degrees and the shorter focal lengths (4.7-mm through 14-mm) are a 7-element design; the longer (18-mm, 24-mm, and 30-mm) are a 6-element design.

The dual-format barrels found on the old 8.8-mm and 14-mm eyepieces are not found on any of the new series. The original series were made in Japan, while the current Series 5000 originates in China. The new styling incorporates a twist-adjustable inverted flat-topped-cone eyecup made of stiff but flexible material, while the older series used a fluted rubber eyecup (and originally had none at all). The new series also abandons the usual round barrel and has a slightly triangular shape when viewed from above. You will not mistake these eyepieces for any other when reaching for them in the dark.

Table 1 — Physical Characteristics and Specifications of the Meade UWA 5000 Series

Focal length	# Elements/barrel	Height *	Weight **
4.7 mm	7 / 1.25″	55 mm	206 gm / 7.3 oz
6.7 mm	7 / 1.25″	58 mm	270 gm / 9.5 oz
8.8 mm	7 / 1.25″	53 mm	269 gm / 9.5 oz
14 mm	7 / 1.25″	50 mm	291 gm / 10.3 oz
18 mm	6 / 1.25″	55 mm	397 gm / 14.0 oz
24 mm	6 / 2″	70 mm	820 gm / 28.9 oz
30 mm	6 / 2″	85 mm	1320 gm / 46.5 oz

*Measured from base (top of the inserted barrel) to top with eyecup retracted.
**Measured without end caps.

The odd shape of these eyepieces has several advantages and disadvantages. First off, the large size for a given focal length takes up more room in an eyepiece case and will not fit many pre-designed cases. The large flange found on the bottom of the eyepiece where it meets the eyepiece holder can present difficulties. This flange can obstruct or even interfere with the setscrews, sometimes making it difficult to tighten the eyepiece in the carrier. On some 1.25- to 2-inch adaptors, the setscrew prevented the eyepiece from seating. Depending on the particular holder, a longer-threaded setscrew or a shim to lift the eyepiece clear of the carrier might be required.

Figure 2 — The old and the new. Here are (from left to right) the older Series 4000 8.8-mm, Series 5000 8.8-mm, Series 4000 6.7-mm UWA, and the Series 5000 6.7-mm. Note the bulge on the left side of the new 5000 Series 6.7-mm. This is a result of its three-lobed barrel.

The slightly triangular design of the centre barrel has one advantage in that it prevents the eyepiece from rolling easily. It also makes it easy to pick a UWA 5000 from other kinds of eyepieces, even in the dark.

Dust caps are an important way of keeping optical surfaces clean: those who are serious about optical cleanliness recognize the value of good-fitting dust caps that are easy to use and stay in place. The soft rubber bottom caps that Meade uses on its eyepieces are a model for the industry. They fit securely and yet are easy to remove and replace. The top dust caps are another story. They are a poor fit and readily fall off the smaller eyepieces. Only the two largest eyepieces have caps that fit reasonably well. In order to store these eyepieces in their designated case, the eyepieces must have the eyecup retracted, which leaves the large lens flush with the top surface and exposed to inadvertent contact. Their only protection comes from the dust caps, which cannot shield the glass if they fall off easily.

The adjustable eyecup moves by screwing the outer section while holding the lower tail. Some of these were quite stiff at first and a few remained stiff to the point where the tail would start to unscrew from the eyepiece before the adjustable upper barrel began to move. Simply tightening the lower barrel solved that issue. Some of the eyecup adjusters remained very loose, while others were fairly stiff — even at temperatures well above freezing. I simulated cold-weather observing conditions by putting both loose and stiff adjusters in the freezer (until they were just below freezing) with predictable results; the loose one came out very stiff but still workable while the stiff one was immovable. This suggests that you might want to set the eyecups at their optimal location prior to cold-weather observing, and just leave them, but then they won't fit in the contours of the eyepiece case.

The eyecup itself is an interesting study in the design of wide-field eyepieces (Figure 3). The entire line of Series 5000 eyepieces has a short eye relief. Any attempt to use the eyecup by threading it upward seemed to cut off access to part of the field of view. There have been reports in other reviews where the author claims that because of the short eye relief the eyecups are best left in the lowest position — in effect, admitting that they are of marginal use. When you first use these eyepieces, there will be a tendency to ignore the eyecups as you try to take in the very wide FOV. However, they do work as a very effective light block and can be helpful in placing the eye in the correct position for viewing. It takes some practice to get it right and it helps if your mounting is sturdy because the best fit is achieved when some pressure is used to press your eye socket against the rubber eyecup. With everything adjusted just so, you can remove extraneous light effectively and still maintain as much of the field of view as you could with the eyecup retracted.

Optical Specifications

In general, the view through these eyepieces can be described as crisp, with very wide fields that provide somewhat short eye relief. All the 1.25-inch eyepieces are parfocal, with the exception of the 18-mm. This is not surprising, as the 18-mm is a 6-element eyepiece, whereas the others all have 7 elements. Because you remove the 1.25-to-2-inch adaptor to use the 2-inch eyepieces, it is not possible to say whether they will be parfocal with the 1.25-inch eyepieces; this will depend on the height of the adaptor used. The two 2-inch eyepieces are parfocal with each other however.

Table 2 — Meade 5000 Series Optical Specifications.

Eyepiece/AFOV *	Eye relief **	True FOV @ 150mm f/6 ***
4.7mm / 82 degrees	~13 mm	26 arc min / .44 degree
6.7mm / 82 degrees	~17 mm	36 arc min / .59 degree
8.8mm / 82 degrees	~15 mm	48 arc min / .79 degree
14 mm / 82 degrees	~15 mm	76 arc min / 1.27 degree
18 mm / 82 degrees	~11 mm	98 arc min / 1.63 degree
24 mm / 82 degrees	~15 mm	132 arc min / 2.20 degree
30 mm / 82 degrees	~20 mm	160 arc min / 2.67 degree

*Focal length and Apparent Field of View are reported according to manufacturer specifications and have not been measured.

**Eye relief is defined as distance from eyelens to image plane. This was measured in a 150-mm f/6 Maksutov Newtonian and agrees well with open eyepiece measurements except for the 30-mm, which differed by 2 mm — the only one with a difference that was outside the margin of error.

***Measured by using the "drift method" of timing the duration for a star near the celestial equator to completely cross the apparent field of view and then applying the following calculation: TFOV= Time (sec) × COS (star declination) × 0.25068474. The star used was Eta Aquila (Declination +1°), so the cosine of the declination (0.99984769) was within the measuring error and could be ignored. NOTE: this measurement depends on telescope used, as TFOV varies with focal ratio.

The issue of eye relief is not straightforward, but it is very important in evaluating wide-field eyepieces. Large fields of view will not be appreciated if you cannot get your eye close enough to take it all in. For those who must wear their glasses, the tight relief of some of these eyepieces will mean that the entire AFOV will not be available at one glance. Conventional opinion suggests that eyeglass wearers require at least 15 mm of eye relief and would be most comfortable with 20 mm or slightly more. Some eyepiece users consider even that to be suitable only for 50° AFOV eyepieces, and would want even more eye relief for the ultra-wide fields in the Meade UWAs. This makes the entire series of UWAs more difficult to appreciate for those who must or want to wear glasses.

Figure 3 — The eyecup in its extended position.

For those who do not wear glasses, the Series 5000 eyepieces are quite usable and the entire 82° AFOV can be taken in by bringing your eye up close, though the large flat-topped eyecup of the bigger models (retracted or extended) might be too large in diameter for some observers to get their eye close enough to take in the entire view. Inevitably, there will be some head turning to take in the entire field. This is quite natural for most ultra-wide-field eyepieces and most viewers have come to expect it.

The antireflection coatings on the new series are typical of industry standards these days; they have a green reflection, where those from the old series were a bluish-purple. A visual inspection reveals that the newer coatings seem to produce a reflection that is less intense than the old coatings but the reflections are not as effective as those seen on the best of modern optics.

Except for the 30-mm, the Series 5000 UWAs all exhibited pincushion distortion; it is more pronounced at the shorter focal lengths. The impact of this distortion for simple viewing of astronomical objects is the subject of debate. While it was noticeable to careful observers when observing astronomical objects, and is more noticeable on terrestrial scenes, it was really only objectionable and disconcerting when viewing rectilinear objects. It had an effect on the drift timings made to determine TFOV, a purely technical matter, but it did not detract from viewing astronomical objects. Such pincushion distortion is found in many wide-field eyepieces.

Figure 4 — The old 6.7-mm and the new. Note the triangular shape of the new version

The Individual Eyepieces

To better document the evolution of the Meade UWAs and the merits of each focal length, we now turn to evaluations of individual eyepieces. These eyepieces, along with some others for comparison, were subjected to tests in several telescopes: an 80-mm f/6 refractor, 150-mm f/6 Maksutov Newtonian, 235-mm f/10 Schmidt Cassegrain, and a 317-mm f/4.7 Dobsonian. It is worth noting that the results occasionally depended on the telescope being used for the assessment, and the results should be evaluated with that in mind.

Meade 4.7-mm UWA Series 5000. This is the shortest focal length in this series. Considering that eyepiece focal length is related to eye relief and that this series in general is not long on eye relief, it comes as a pleasant surprise to find that the 4.7-mm is fairly generous to eyeglass wearers. The eyepiece exhibited moderate pincushion distortion when viewing rectilinear objects. On planets such as Jupiter, there is a general light haze but no objectionable ghost reflections.

Meade 6.7-mm UWA Series 5000. The 6.7-mm is somewhat out of step with its brethren in that it is slightly taller and has more eye relief than the eyepieces "on either side" in the series. The eyepiece was compared with its predecessor, the Meade 6.7-mm UWA Series 4000, and the 7-mm Nagler Type 1. The on-axis view of Jupiter in the 9.25-inch SCT showed a faint but general glare across the entire FOV but there was little flare around the planet itself. No other false images were detected. There was noticeable pincushion distortion. When used in the 150-mm Maksutov Newtonian there was no overall glare but instead, a slight flare around the planet. On axis, the view was brighter than its predecessor in the 4000 series and brighter than the slightly yellow view in the Nagler Type 1. The view on axis was also a bit sharper and showed more contrast than the other two. The difference was subtle but distinct, and the new Series 5000 was the easy choice for viewing Jupiter among the three.

Putting Jupiter over to the edge of the FOV revealed a different story. The new Meade 5000 showed some field curvature and the greatest amount of distortion. The lateral chromatic aberration was also most pronounced in this eyepiece, with large amounts spectral smearing across the planet. When turned to the limb of the Moon, there was a prominent yellow fringe — more so than the two older eyepieces. Therefore, while it had the best on-axis performance, it also showed the poorest edge-of-field presentation in comparison with two of its predecessors. However, since planetary viewing does not require good edge performance, this new eyepiece was a noticeable improvement on the earlier generation.

The same poor edge performance held true for the 6.7-mm when viewing nebulae and clusters. Not only was there noticeable lateral chromatic aberration, but also some field curvature. The amount depended on the scope used and was hardly noticeable in some instances. First glances at most objects through the three eyepieces suggested that the Meade 5000 was the superior eyepiece, but once the entire FOV was inspected, the edge performance of the Meade was found to be deficient when compared to earlier generations.

While the eyepieces were being swapped back and forth, the 6.7-mm gave a sensation of slightly less magnification than the previous 6.7-mm UWA — its magnification seemed closer to that of the 7-mm Nagler. This was more obvious when viewing the Moon through the 9.25-inch telescope, as the Moon fit much better within the FOV of the newer 6.7-mm than its predecessor despite having 2 degrees *less* AFOV and the same focal length. The 80° AFOV of the Nagler, with lower magnification, also could not fit the Moon as well as the new Series 5000. Measuring the TFOV of the new and old UWAs revealed that the new one, with a claimed AFOV of 82 degrees, had a very slightly *larger* TFOV than the 84° AFOV (measured in the Mak/Newt as 36 arcmin vs. 35 arcmin). Parameters such as image-magnification distortions (barrel or pincushion distortions) could account for this discrepancy, or, less likely, that the stated focal length or AFOV are not accurate.

Meade 8.8-mm UWA Series 5000. This eyepiece is slightly shorter (53 mm *vs.* 54 mm) and much lighter (269 gm *vs.* 406 gm) than its 4000 predecessor. The eyepiece comes with 1.25-inch barrel, compared to the older model that incorporated a dual-format 1.25- and 2-inch barrel. The old version stood only 45 mm tall if used in a 2-inch holder. In viewing Jupiter, the newer eyepiece was brighter and just as sharp as its predecessor in the Series 4000, but, as it turned out, the dimmer view of the older 8.8-mm was of the right intensity to best reveal contrast features on Jupiter with the telescope I was using. On objects dimmer than Jupiter, the newer eyepiece should render the better view. This eyepiece also exhibited slight field curvature and slight lateral chromatic aberration, but its edge performance was superior to its Series 4000 predecessor, which suffered from strong astigmatism at its edge. The 8.8-mm 5000 Series eyepiece showed the most consistent behaviour from centre to edge of the short-focal-length Series 5000 eyepieces. On M13, the Series 5000 showed a slightly darker background and was just as sharp in rendering the stars of the globular cluster. The view was preferable to both the Series 4000 and another rival from a previous generation, the Speers-WALER zoom set at 8 mm. The Speers was close on contrast, just as sharp, and had better edge performance, but M13 occupied only the central region and this is where the Series 5000 was more pleasing. In comparing the old and the new Meade, there was a slightly anomalous result in that the old eyepiece was as sharp on-axis as the new version but had poorer edge performance, the opposite of most comparisons of the new UWAs with their previous generation.

Meade 14-mm UWA Series 5000. This versatile eyepiece is much shorter (50 mm *vs.* ~90 mm) and lighter (291 gm *vs.* 670 gm) than its older cousin. In tests on Jupiter, it yielded the slightest flare around the planet when viewed through a Maksutov Newtonian but produced only a slight background haze/glare when viewed through the f/10 SCT. Like the others, it was very sharp and had good contrast on axis. The 14-mm showed some moderate pincushion distortion. Compared to one of its old competitors, the Speers-WALER 14-mm, the UWA had less flare, similar contrast, and was very close in sharpness. Off axis, the Meade had slightly more lateral chromatic aberration than the Speers-WALER. Most of the Meade's edge-of-field issues were due to a curved FOV, as refocusing resulted in a relatively sharp edge image that showed only slight lateral chromatic aberration. Both eyepieces showed sharp open clusters with the Speers slightly better at revealing the faintest stars.

Meade 18-mm UWA Series 5000. This eyepiece has six elements and is purported to be a scaled-down version of the Meade 30-mm UWA. It is not parfocal with the other 1.25-inch barreled eyepieces and has the shortest eye relief of the series. On Jupiter, there was a faint ghost image of the planet that moved opposite to the real image. When centred, the images were superimposed. The 18-mm exhibited some moderate pincushion distortion.

There was no 18-mm UWA in the old series, and Meade's widest FOV eyepiece was the Meade Super Wide Angle (SWA) 18-mm. The older 18-mm SWA was also a six-element design that had an AFOV of 68 degrees. This older eyepiece shows a little more flare around Jupiter than the newer but was just as sharp on-axis. The edge of the newer 18-mm, with its 82° AFOV, showed more chromatic aberration but otherwise was much better controlled than the 68° AFOV of the old eyepiece, which showed astigmatism and slight curvature of field. The new eyepiece is a notable advance over the earlier 18-mm SWA.

Meade 24-mm UWA Series 5000. This eyepiece comes with a two-inch barrel. It has adequate eye relief but the top of the eyepiece is getting large enough in diameter that many observers might have trouble getting their eye properly positioned over the centre. Like its siblings, the eyepiece was very good on-axis, showing only the slightest pincushion distortion. Compared to the older well-regarded 20-mm Nagler Type 2, the Meade was very close in sharpness on-axis, with slightly better contrast; it only suffered towards its edge. Again, field curvature was the culprit as refocusing brought about an acceptable edge. When trained on bright objects such as Jupiter, it showed a bright ghost image that moved opposite to the real image, and like the 18-mm, the ghost image became superimposed when centred.

Meade 30mm UWA Series 5000. This behemoth has been described as having cartoon-like proportions, but if your telescope can handle the weight and you have no issues securing it to your focuser or diagonal, then it can provide some very crisp wide-field views. Like the 24-mm, it shows a prominent ghost image on bright objects such as Jupiter and has a slight (though smaller) field curvature. It did not have any pincushion distortion of note. It does show slight lateral chromatic aberration at about 75% out from centre, but the image on the whole is quite pleasing. There was no equivalent to this eyepiece in Meade's old series and the older Meade SWA 32-mm had significantly more lateral chromatic aberration and other distortions — especially at fast focal ratios such as that on the f/4.7 scope. The newer eyepiece is a superior eyepiece to the older, smaller-FOV version.

Conclusion and Reflection

The new Meade Series 5000 UWAs are a radically styled set of eyepieces with some unusual physical characteristics and features. They are heavier and in some ways more awkward in interfacing with some of our current equipment. Optically they are much more agreeable and yet they still retain some optical and mechanical shortcomings.

In comparing the new Meade UWA eyepieces to the previous series and some of their early rivals, a pattern emerges wherein the latest series seems to have emphasized superior on-axis sharpness and contrast at the expense of edge performance. The strategy of using six- and seven-element designs has resulted in eyepieces that are preferable to the previous eight-element design offerings. Yet this concept flies in the face of the mantra behind the ultra-wide field eyepieces — that of delivering the widest, crispest field of view possible.

The trend to ultra-wide-field has two general facets. One is an optical goal, to render the widest field of view possible with the maximum amount of sharply defined sky that can be taken in with one glance. Not only is this beneficial for things such as comet hunting and object location, but it allows large-scale objects to be framed appropriately at higher magnification. Alas, some observers just are not tolerant of edge imperfections and find them too distracting.

The second objective is to satisfy the observer's aesthetic/psychological side, in that a wide AFOV is more pleasing to the eye generally. The lack of a confining edge of view seems to "take the apparatus out of the visual experience." The term "immersive" has been used to describe this effect, but there seems to be a limit to the endeavour. In doing these tests, I found that when the 82° AFOV eyepiece was removed and the 70° eyepiece put in its place, there was an immediate "slightly cramped" sensation with the smaller AFOV that soon disappeared, still leaving me with an expansive porthole view. The sensation of immersion is a matter of degree, but it seems the law of diminishing returns sets in around 65 or 70 degrees and larger fields of view leave little lasting impression on the observer.

Meade's approach to this bifold strategy succeeds in satisfying the second objective. They provide wide, immersive fields of view that are sharp and high-contrast on-axis, giving views that are pleasing and visually satisfying. They accomplish this at the cost of edge sharpness. The penalty is not that great, in that a lower-quality edge performance is acceptable to most viewers. Unless you tend to view planets at the edge of the field, make crucial measurements of star fields, or get bothered to distraction by lateral chromatic aberration and slightly distorted stars at the periphery, the Meade UWAs can be acknowledged to have made a step in the right direction.

The UWA eyepieces are reminiscent of the old Konig eyepieces, which were incredibly good on-axis but had poor edge performance compared to their contemporaries. Now Meade, in the 21st century, has given us an eyepiece that preserves that wonderful Konig on-axis execution but also has a better edge performance than that venerable design. For many observers, the edge performance, while not perfect, will be "good enough" and a fair exchange for the on-axis performance. It seems that Meade felt no need to escalate the AFOV wars and hints that some natural limit of human and optical interaction has been reached.

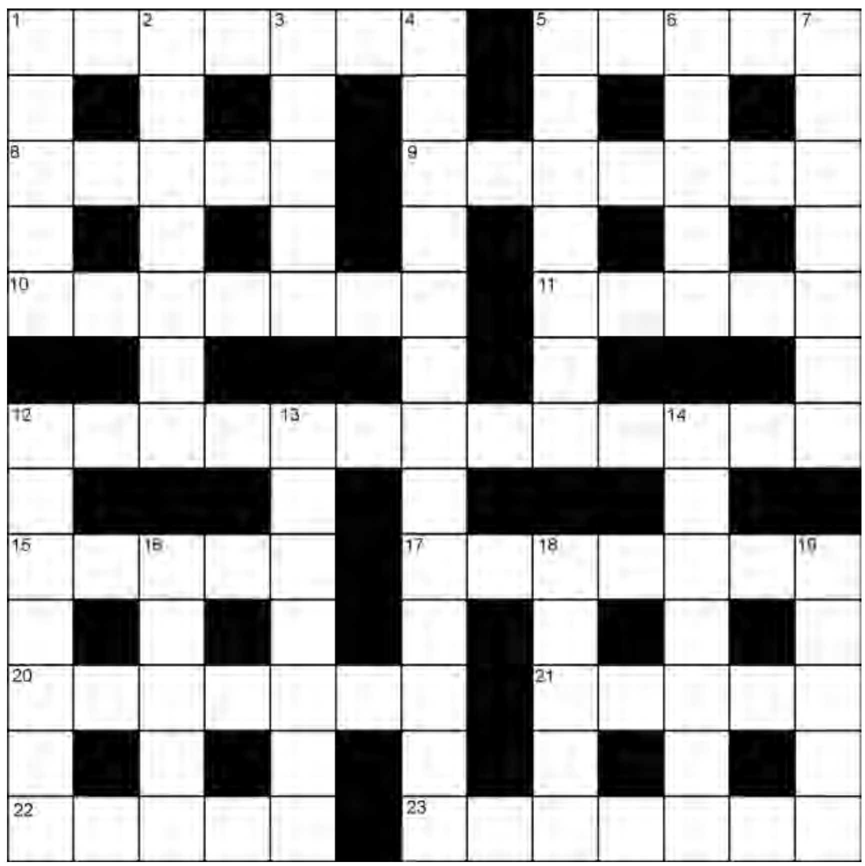
Acknowledgments

I thank John Hleck of Sideline Enterprises for graciously loaning the entire set of Meade Series 5000 UWAs for this report. I also thank Ray Andrejowich and Stan Runge for providing other eyepieces for comparisons.

Gerry's interest in astronomy extends at least far back as his second spoken word, which was "moon," but it took a leap forward when he obtained his first department store telescope in 1969. His formal education in History and Philosophy of Science from several universities causes him to take a broad historical approach to most subjects, including astronomical equipment. Gerry is a scope-aholic and suffers from ocularosis, which is defined as the inability to ignore eyepieces and other optical equipment.

Astrocryptic

by Curt Nason, New Brunswick Centre



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Society News/
Nouvelles de la société

October 2007

by James Edgar, Secretary (jamesedgar@sasktel.net)

The General Assembly in Calgary was a well-run weekend — one that combined bits of astronomy, talks, papers, business, camaraderie, networking, and, most of all, fun! Congratulations to the Calgary Centre for all their hard work and successful conclusion to this exciting weekend, where three Societies met, mingled, and worked — AAVSO, ALPO, and RASC. If you've never attended a GA, plan on going to one soon. The promo we received from the Hamilton, Mississauga, and Toronto Centres on July 1 promises that next year's GA will be a hit — Astronomy Night In Canada!

The 2007 RASC Award Winners - Bruce McCurdy, Alan Dyer, and Dr. Rajiv Gupta.
Photo: James Edgar

A momentous change in our Society occurred at the GA — the formation of a trial Board of Directors, called the Board Pilot Committee (BPC). The BPC consists of the Society executive plus seven elected volunteers. The intent is that the BPC will run the affairs of the Society, under the purview of National Council, and requiring that only 12 people meet rather than the 45 or so that usually gather at a Council meeting. This one-year trial gives the Society the opportunity to continue in a more permanent way, should the first year's experiment prove successful. The BPC expects to formulate a 2008 budget, a long-range operating plan (including events for IYA2009), and the beginnings of a By-Law review and revision. The Board Pilot Committee members are: Scott Young, Dave Lane, Mary Lou Whitehorne, Alan Whitman, James Edgar, Randy Attwood, Bonnie Bird (*Ex Officio*), Brian Battersby, Debra Ceravolo, Paul Gray, Denis Grey, Kim Hay, and Patrice Scattolin. Two alternates are Ron Jerome and Charlene Schiffer.

The BPC plans to hold its first face-to-face meeting at the Carr Astronomical Observatory near Toronto over the weekend of September 27 to 29. (By the time you read this, the BPC will have completed this inaugural meeting.)

The GA also presented the opportunity to honour three richly deserving Society members, Dr. Rajiv Gupta and Bruce McCurdy both received the RASC Service Award, while Alan Dyer was presented the Simon Newcomb Award. See the story on our Web site for full details - www.rasc.ca/awards.

A surprise award, presented by Arne Henden, Director of the AAVSO, was a special Director's Service Award, given to Regina Centre Vice-President Vance Petriew. Follow this link for full details — `www.aavso.org/aavso/membership/dir_petriew.shtml`

The zany side of our Society usually springs forth annually with the building of the Human Pyramid — immediately following the group photo. This year was notable for the splendid way in which the partially built pyramid collapsed in a flurry of arms, legs, and torsos.

Arne Henden presents the AAVSO 2007 Director's Service Award to Vance Petriew.
Photo: James Edgar

The 2007 Human Pyramid (almost)

Photos: James Edgar

Great Images

From the October page, *RASC Observer's Calendar, 2007*

Woolsthorpe Rainbow
Isaac Newton was born at Woolsthorpe Manor in 1642. It was here in 1666 that Newton formulated his initial ideas concerning gravitation and the spectral nature of light, symbolized by the apple tree and the rainbow. This one-in-a-million photo has been featured in over 30 publications around the world.

— Photo by Roy Bishop

Own the Back Cover

Your photo — in full colour — could grace the back cover of the *Journal* in February, April, or June next year. We are pleased to announce the first ever *JRASC* photo contest, in recognition of the growing capability of the RASC membership and the establishment of the new RASC Astroimaging Group.

Photos must be submitted on or before 2007 December 31, conform to the normal requirements (300 dpi in final size) of the *Journal's* graphical standards (`www.rasc.ca/journal`), and be accompanied by a description of the object, the photographic details, and non-exclusive permission to reproduce in the *Journal.* Images must be in digital form, but may include sketches, paintings, film photographs, and drawings, provided they are converted to a digital format before submission.

The competition will award "the back page" to submissions in three categories: deep-sky images; wide-angle photographs that include at least a part of the landscape; and scenes of Centre outreach activities. Winners will be expected to provide a short bio prior to publication. Images submitted may be published at other times and places in the *Journal,* with credit to the owner. Please send submissions to `editor@rasc.ca`.

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA

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

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

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c/o Telus World of Science, PO Box 2100 Stn M Location 73,
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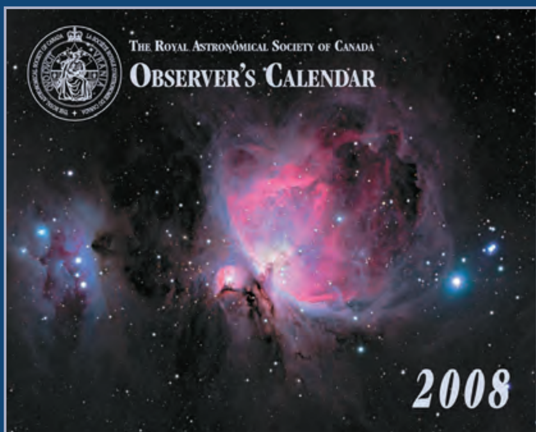

Observer's Calendar — 2008

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

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

Individual Order Prices:
$16.95 Cdn/ $14.95 US
RASC members discount: $2.00 Canadian members ; $1.50 US members
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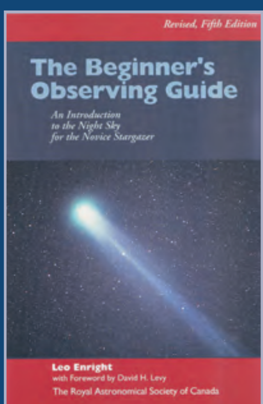

The Beginner's Observing Guide

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

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Price: $19.95 plus shipping & handling.

Skyways: Astronomy Handbook for Teachers

Teaching Astronomy? Skyways Makes it Easy!

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

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

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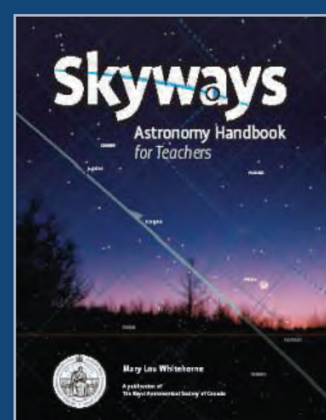

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