



Carl Knight and Tessa Hiscox with the Meade Etx 125 Tessa was lent for her project. Story p21.

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We're trying to encourage more people to become interested in measuring and analysing variable stars - as you would expect from an organisation called Variable Stars South. Some astrophotographers may be persuaded to add variable stars to their present pursuit of deep sky objects, others read much about astronomy but only do at the infrequent star parties. So get out the telescope with the warmer nights coming up and become an observer.

Practical projects for students

Carl Knight in the Manawatu has been assisting a year 11 student, Tessa Hiscox, with a Cepheid observing project which has aroused considerable interest with secondary teachers in the area. This is a change from what seems to be the normal approach from astronomical societies to teachers - telling them about what's out there, but not involving the student in anything practical - so the interest doesn't continue or, more usually, doesn't even begin. Carl's more practical approach looks rewarding - see his article on page 18.



In this context it was good to see the innovative approach of John Hearnshaw with students being invited to the RASNZ Annual Conference at Tekapo and recently there has been a competition associated with the Aoraki Dark Sky Trust - Starlight Festival - sponsored by Canterbury University.

So first we need people to be attracted to astronomical groups in the expectation that some of them will move into our variable star field. And Cepheids are one of the few areas in astronomy in which change can be observed on a useful timescale. Carl needs interesting practical projects, which do not involve complex equipment, to make his efforts even more successful. Any ideas out there?

One idea I explored a few years ago was to make a video presentation of eclipses of the cataclysmic variable, Z Chamaeleontis. This star has an orbital period of about 107.3 minutes and in quiescence has fades from ~ 14.0 to 15.8 and recovers in about 10 minutes overall. It's even more striking as there is star of $V = 14$ a few arcminutes away for comparison. But it's unfortunately a big telescope object.

Another idea is based upon the type of concept employed in the Baade-Wesselink method - using the colour changes in a pulsating variable star to determine an approximate distance. It's most effective with Cepheids, where most of these are very luminous objects at great distances, well beyond the limits of accurate trigonometrical parallaxes. The idea is still being explored but will appear shortly on the website.

Donations are needed

About two years ago the small annual membership fee of \$20NZ was cancelled on the basis that our funds could be adequately funded by donations from members. This has not proved entirely successful as, like me, noone gets around to it! One recent expenditure was to help the new director of the AAVSO, Stella Kafka, to attend the two conferences at Tekapo, which established valuable personal relationships, and other expenses of showing a strong presence at these conferences, have eroded these funds significantly. We produced two posters for display at Tekapo and these have since been displayed at meetings in Honolulu and US.

One area where this may affect our activities is in the encouragement of new members. Alan Baldwin heads the group working in this field, with assistance from Carl's efforts as mentioned above and described elsewhere in this newsletter. Alan has attended star parties with various groups in his local area. The cost of preparing material for such activities should be paid by VSS.

We may also wish to encourage other astronomers to participate in our meetings - such as VSSS4 which will be held in Sydney on 28 March, 2016, by providing a nominal assistance with travel and accommodation of leading professionals. This will not be a cost at Sydney but if we ever decide to run a stand-

alone conference or meeting we will need to cover many of the arrangements in advance.

So perhaps you could help us now with a donation? To pay by the on-line banking system use our bank account: ANZ, Variable Stars South, number 06 0337 0065870 00.

To pay via PayPal, in the VSS website select the **About VSS** tab, then click on **Donate to VSS**, click on **Donate**, login into your PayPal account, click **Donate \$30.00 Now**. There is an opportunity to change the currency, but Bob Evans, our treasurer and membership secretary, sees no reason for that.

Binary stars

David Moriarty has made a very interesting analysis of the eclipsing binary, TW Crucis, and this was published in the JAAVSO, available at: <https://www.aavso.org/apps/jaavso/article/3115/>

This brings to mind other binaries but ones with much longer periods: BL Telescopii which is just emerging from the long awaited eclipse, a review of which star will be put together by Peter Williams for the January newsletter, and a few similar objects. One very challenging object is V777 Sagittarii with eclipses every 936 days lasting for 51 or so days. Regretfully of very low amplitude but visible next April and May.

R Corona Borealis stars

Three of our visual observers follow these stars closely and recently V854 Centauri has begun another fading episode as announced by Peter Williams and confirmed by Andrew Pearce. Peter discusses this in more detail elsewhere. These stars are thought to be in a very late stage of evolution, and are comprised mainly of helium and carbon, of low mass - less than the Sun - but extremely luminous, with low amplitude pulsations. RY Sagittarii shows these pulsations with a period of around 35 days, the star itself being marginally naked eye in good locations. The fades are associated with ejected material which has formed into dust clouds. Maybe the pulsation periods would form a long term target for DSLR observers?

VSS Symposium 4

This will be held on Friday 28 March 2016, at the University of Sydney - see below.

There will be a casual precursor on the Thursday afternoon. This is our first formal meeting as a group in Australia and we look forward to some interesting papers and discussions.

VSS Symposium 4 – *David O'Driscoll*

The National Australian Convention of Amateur Astronomers (NACAA) will hold its 27th meeting in Sydney over the 2016 Easter long weekend. NACAA will be hosted by the Sutherland Astronomical Society Inc, and will be held at the new Law Annexe at the University of NSW. Details of accommodation and the like will be posted to the NACAA website soon.

While details of the programme are still being finalised, it is intended that VSS will hold its 4th Symposium on the Friday (March 25 – Good Friday).

Members of the VSS community are invited to submit papers and posters via the NACAA website (<http://www.nacaa.org.au/2016/proposal>) for either the Symposium (most likely focused on specific research reports and the like) or the main NACAA meeting (more general variable star observing subjects).

More details of the event can be found at the NACAA website, and if you register your interest you will receive alerts as they are posted.



A letter from the director of the AAVSO

Dear Colleagues,

A visit to New Zealand is always a great attraction for anyone on the planet. A visit with one of the most active astronomical societies in the world, with access to an incredible unexplored night sky, is a true privilege. At the beginning of my trip, I left a weather-wounded Boston at the end of a very harsh winter, during which I was starting my tenure at the AAVSO. At the same time, for me New Zealand represented beautiful landscapes and the southern hemisphere night sky that I cherish. Visiting with members of astronomical societies around the country, including RASNZ and VSS added to this picture the warmth and intelligence of the southern hemisphere's astronomical community.

I had the chance to meet with members and observers from the astronomical societies in Wellington and Auckland, to discuss research interests and to share observing stories. The various projects people are working on are impressive, and their passion for observing is really inspiring. I left from our meetings reluctantly and with the best impressions. Time was limited.

The Mt John 50th anniversary symposium was a celebration of the great observatory's contribution to science. The story of Mt John Observatory is a testament of resilience and dedication of people who, despite various difficulties, envisioned and built a facility with international recognition, which produces cutting-edge science. Imagine trying to take data in the middle of a deserted snow-covered mountain with only a rough cabin to shelter and protect you. For those of us whose observing experience is confined to the luxuries of the 21st century observatories, stories shared by the speakers were equivalent to time travel.

The RASNZ meeting was exactly what a successful meeting should be: it included presentations of great new results and projects, along with talks on the history of astronomy. It also allowed enough time for interactions among the participants and exchanges of ideas. I talked to VSS members, including the VSS leadership team, and we brainstormed on how we can better serve our variable stars community. And, of course, we talked about mutual science interests.

So, here's my take-home message from my various meetings: We are all concerned for our data. When one is studying stars that exhibit unusual (and unpredictable) behaviours, one should be very careful and truly confident of one's data reductions and results. This requires deep knowledge of our detectors, filter transmission curves (and transformations to a common system), sky conditions, telescope idiosyncrasies, and software knowledge (both for data reduction and analysis). We all have this "eureka" moment... especially when all of the above works well! We are all eager to communicate our results – sharing one's outcome of labour is a reward by itself! And we all hate bad weather! (I don't think I need to elaborate on that.) The variable night sky continues to amaze and confuse us all, keeping us alert and interested.

The people that I was fortunate to meet and the new friendships that we formed are what made this trip the rich, vibrant experience that it was. I am looking forward to strengthening the ties between AAVSO and VSS/RASNZ, while "enabling anyone anywhere to participate in scientific discovery through variable star astronomy", and I foresee that I'll be back in that part of the world in the near future.

Best wishes – clear skies,

Stella Kafka.



With a few precautions CCD photometrists imaging through a medium to long focal length telescope can safely ignore the effects of atmospheric extinction. This is not always true for DSLR photometrists using a standard or telephoto lens where the relatively wide field of view can lead to significant differences in airmass across the image. This article will hopefully explain several aspects of extinction and quantify their effects on photometry for typical CCD/telescope and DSLR/lens scenarios.

Probably the most obvious effect of atmospheric extinction is dimming and reddening of the sun as it sets, but starlight is similarly affected. There are a number of factors involved including Rayleigh and aerosol scattering and molecular absorption, principally by ozone. For a normal atmosphere Rayleigh scattering from gas molecules dominates.

The amount of dimming is proportional to path length through the atmosphere (primary extinction). Shorter, ie bluer, wavelengths are dimmed more than longer wavelengths. Furthermore, the colour index of the star also has a small additional effect on the amount of dimming (secondary extinction). In a wide field of view image stars nearer the horizon can have significantly greater airmass than stars further from the horizon, thus leading to different amounts of dimming (differential extinction).

Below we illustrate each of these concepts using DSLR time series observations of non-variable stars, and theoretical airmass calculations.

Primary extinction

At the zenith (zenith angle, $\zeta = 0^\circ$) the path length of starlight through earth's atmosphere is defined as airmass $X = 1$. Airmass increases as ζ becomes larger, at first very slowly but more and more rapidly as a star approaches the horizon.

Figure 1 shows the raw instrumental magnitude in each of the DSLR color channels for a non-variable star plotted as a function of time (top left panel) and as a function of airmass (top right panel). When seeing is steady and transparency remains constant throughout the night (a photometric night) measured instrumental magnitude will be a linear function of airmass, as shown in this plot.

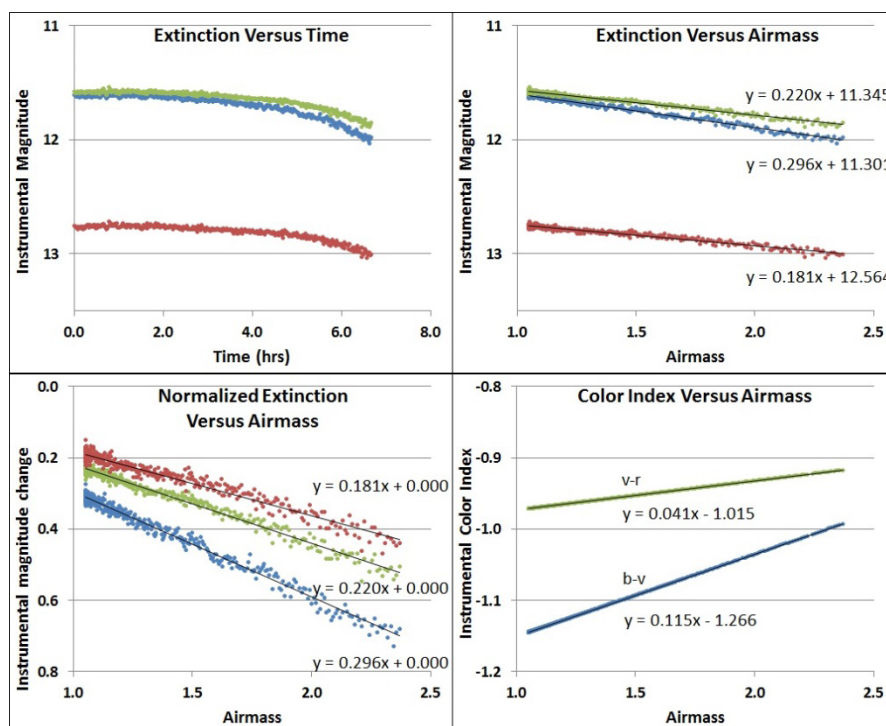


Figure 1. Top left: Change in instrumental magnitude with time as a star moves from high in the sky to low elevation. Colours represent red, green and blue DSLR channels. **Top right:** Same data plotted as a function of airmass. **Bottom left:** Same data as above, but normalised to magnitude 0 at airmass = 0, ie above the atmosphere. **Bottom right:** Change in instrumental (b-v) and (v-r) colour indices with increasing airmass.

To a first approximation the slope of the line is the primary extinction coefficient and is greatest at shorter (i.e. bluer) wavelengths. This is more easily seen in the bottom left panel of Figure 1 where instrumental magnitudes have been normalised to magnitude 0 at $X = 0$, ie above the atmosphere. We can see

that even at the zenith the star has been dimmed by 0.181, 0.220 and 0.296 magnitude in the red, green and blue DSLR channels, respectively. Each filter has its own primary extinction coefficient which is a function of the effective wavelength of the filter. This results in the star's colour indices becoming more positive, ie redder, as airmass increases (bottom right panel of Figure 1).

Primary extinction coefficients (denoted by k') can vary from night to night, even throughout a single night, as atmospheric conditions change. The principal cause is variation of aerosol content of the atmosphere, eg dust, smoke, water droplets, etc. Figure 2 shows two examples of extinction on nights of variable transparency. The analyst needs to decide if small fluctuations are acceptable before applying extinction corrections. Differential photometry using uncorrected data from non-photometric nights may yield less accurate but still useful measurements.

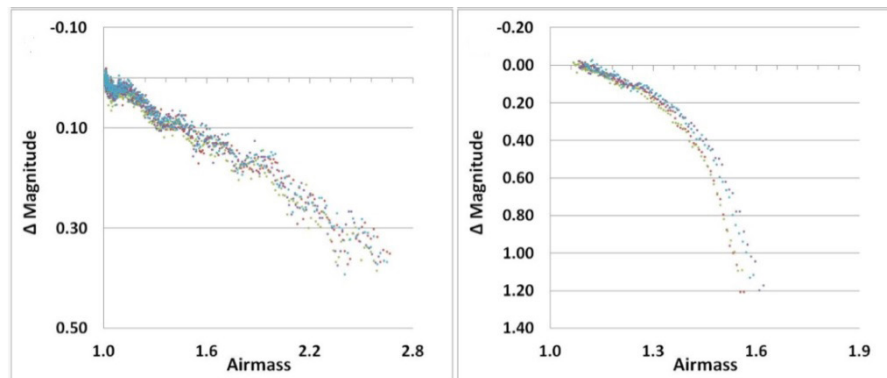


Figure 2. Normalised raw instrumental magnitude change plotted as a function of airmass for two nights with variable transparency. **Left:** Waves of thin cirrus cloud passing across the field throughout the session. **Right:** Steadily increasing extinction due to buildup of smoke haze.

Secondary extinction

Secondary extinction is a function of both airmass and colour index of the star and is a consequence of the finite width of the spectral transmission curves of the broadband RGB filters in a DSLR, and CCD photometric filters.

Figure 3 shows the transmission curve of a DSLR green filter and generalized energy distribution curves for a blue and a red star. The blue star has relatively more intensity in the short wavelength side of the filter window compared to the red star. We know from the discussion above that shorter wavelengths suffer more dimming, so the blue star will dim slightly more than the red star. Different filters have their own specific secondary extinction coefficients.

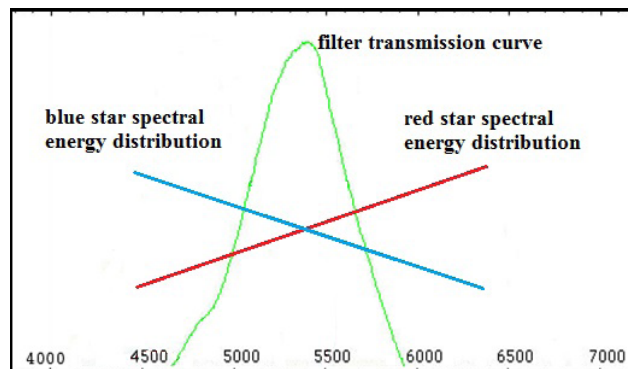


Figure 3. Schematic showing broadband filter transmission curve and energy distribution of a red and a blue star.

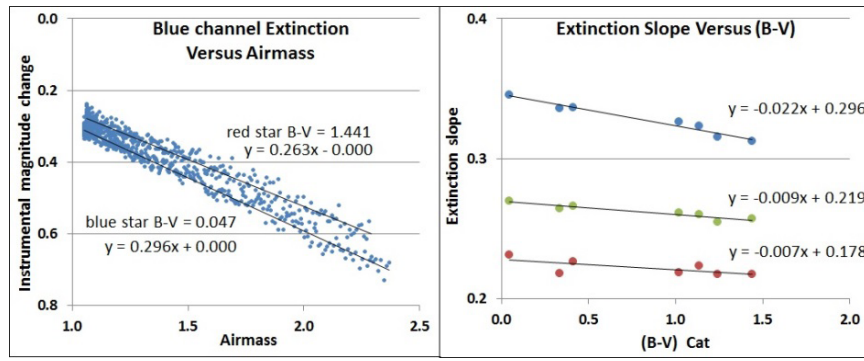


Figure 4. Left: Normalised blue channel extinction for a red and a blue star in the same time series of images showing different extinction rates (ie slopes). **Right:** Plot of extinction rates as a function of catalogue (B-V) colour index for each colour channel.

The left panel of Figure 4 plots normalised blue channel instrumental magnitudes for a red (B-V) = 1.441 and a blue (B-V) = 0.047 star plotted as a function of each stars individual airmass, measured from the same images. The difference in slope is the result of secondary extinction.

The right panel of Figure 4 plots the slope of instrumental magnitude versus airmass curves (extinction slope) as a function of (B-V) colour index of 7 non-variable stars in the time series images. All three colour channels show a small but definite dependence on colour index, with the blue channel showing the largest effect. Secondary extinction coefficients are given by the slope of the lines and primary extinction coefficients by the y-intercept value.

Secondary extinction coefficients (denoted by k'') should be relatively constant unless some aspect of the imaging system changes (filters, lenses, sensor, etc.).

Differential airmass

If all stars of interest in an image had the same airmass and colour index they would be dimmed by exactly the same amount by the atmosphere. Primary and secondary extinction would thus not be a problem. Narrow field of view photometry can approximate this situation if comparison stars with (B-V) values very close to that of the variable are chosen.

The left panel of Figure 5 shows the difference in airmass of two stars with separations indicated on the right hand side, plotted as a function of the zenith angle of the first star. Curves with positive labels indicate the second star is located west of the first star. Negative labels indicate the second star is east of the first star.

Differential airmass, ΔX , increases as the stars move from the zenith toward the horizon and amounts to only ~ 0.07 airmass for separation of 1° at $\zeta=60^\circ$. ΔX is even less for smaller separations typical of fields of view through medium to long focal length telescopes.

The situation is not so good for wide field of view images typical of DSLR photometry with standard or telephoto camera lenses, as shown in the right panel of Figure 5. For separation of $+16^\circ$ at $\zeta=60^\circ$ we have ΔX of ~ 2.5 airmass.

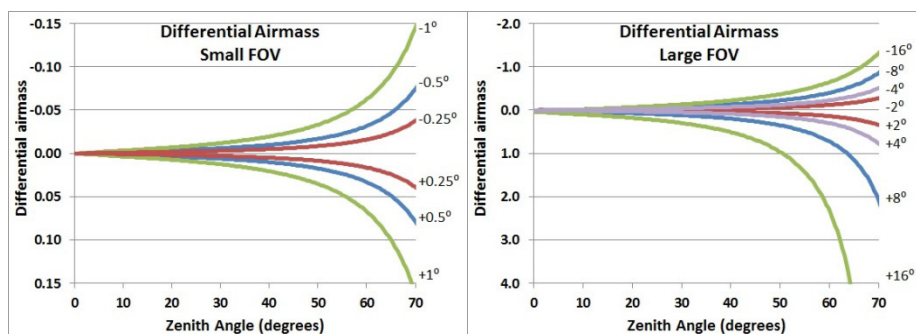


Figure 5. Left: Differential airmass as a function of star one zenith angle for typical telescope fields of view. **Right:** Same as above but for fields of view typical of camera lenses used for DSLR photometry.

Differential extinction - bringing it all together

So what does this all mean for DSLR photometry, how much effect does differential extinction have on instrumental magnitudes measured from wide field images?

Wide FOV situation

Let's take a typical case of a 100mm f.l. lens and APS-C sized sensor (14.9 x 22.3mm). The FOV will be 8.5° by 12.7°. If the target variable is at zenith angle 60° and centered in the image then a comparison star could be up to 7° away in one corner of the frame. From Figure 5 we can estimate maximum ΔX to be ~0.6 airmass for this scenario.

From Figure 4 we have the following primary extinction coefficients in each color channel:

$$K'_b = 0.296 \text{ mag/airmass}$$

$$K'_v = 0.219 \text{ mag/airmass}$$

$$K'_r = 0.178 \text{ mag/airmass}$$

Therefore differential primary extinction will be as much as:

$$\Delta'_b = 0.296 \times 0.6 = 0.178 \text{ mag}$$

$$\Delta'_v = 0.220 \times 0.6 = 0.132 \text{ mag}$$

$$\Delta'_r = 0.181 \times 0.6 = 0.109 \text{ mag}$$

Secondary extinction will be zero if both stars are the same colour. However, if one has $(B-V) = 0.100$ and the other $(B-V) = 0.600$ then $\Delta(B-V) = 0.500$.

From Figure 4 we have the following secondary extinction coefficients:

$$K''_b = 0.022 \text{ mag/airmass}/\Delta(B-V)$$

$$K''_v = 0.009 \text{ mag/airmass}/\Delta(B-V)$$

$$K''_r = 0.007 \text{ mag/airmass}/\Delta(B-V)$$

Thus differential secondary extinction will be as much as:

$$\Delta''_b = 0.022 \times 0.6 \times 0.500 = 0.007 \text{ mag}$$

$$\Delta''_v = 0.009 \times 0.6 \times 0.500 = 0.003 \text{ mag}$$

$$\Delta''_r = 0.007 \times 0.6 \times 0.500 = 0.002 \text{ mag}$$

Second order extinction has a much smaller influence than primary extinction.

Total differential extinction for this scenario on this particular night would be as much as 0.185, 0.135 and 0.111 magnitudes for the blue, green and red instrumental magnitudes, respectively. Clearly we need to correct for primary differential extinction at least.

Narrow FOV situation

Now let's consider a scenario where the variable and comparison star separation is 0.25°, typical of telescopic CCD photometry. All other assumptions and extinction coefficients remain the same. From Figure 5 we estimate ΔX to be ~0.02.

Therefore differential primary extinction will be as much as:

$$\Delta'_b = 0.296 \times 0.02 = 0.006 \text{ mag}$$

$$\Delta'_v = 0.220 \times 0.02 = 0.004 \text{ mag}$$

$$\Delta'_r = 0.181 \times 0.02 = 0.004 \text{ mag}$$

Secondary differential extinction will be much less than a millimag in all colour channels. In this situation (primary) extinction correction is only necessary for photometry programmes requiring the highest accuracy.

Summary

Differential extinction is not normally a problem for narrow field of view (<0.5°) images if comparison stars have the same colour as the variable. On the other hand, for wide field of view images typical of DSLR photometry differential extinction can be very significant, and must be corrected. However, how we go about performing this correction is a topic for another day.

Introduction

You've just bought a small telescope and after looking at all the spectacular objects in the sky are looking around for some real scientific astronomy to do. Maybe you've heard of variable stars as an area where you can do this but which ones should you try - and which of them are interesting?

Let's consider your telescope first. Small usually means something between 60mm and 200mm in the lens or mirror diameter and for it to be used effectively it should be on a solid mount. The eyepieces will be simple and for any work in the variable star field moderately low magnifications and wide fields are best. An observatory is an unneeded luxury - a good chair with a table to one side on a deck shaded from light is adequate.

Don't be dissuaded by the magnitude limits - the larger your telescope the harder it is to use effectively and the less personal control you have over the observations you will make.

Which stars do you observe?

To some extent this will be decided by the limits of your telescope. A 100mm telescope in moderately bright city skies will see comfortably down to magnitude 10, a 200mm to magnitude 11.5. But there are still around 200,000 stars visible at any one time for the first, 500,000 for the larger size. And these brighter stars are often the most interesting and understudied.

The other aspect is how fast does the brightness change? We need some stimulation and rewards in a reasonable time. Cataclysmic variables are spectacular in this respect but most are quite faint and only a dozen or so come within the range of these telescopes during the outbursts - which range usually from a month to a year between. So maybe they are interesting as a side issue but not the main project.

Historically, Mira stars have been targets for amateur observers. But now their periods and amplitudes are well known and understood. It is only those which show sudden period changes that are exciting. Statistically, it seems that 1% of Mira stars will show such a variation in a century. And in these the period will change by about a day every two years. There have been two notable exceptions, BH Crucis and LX Cygni, where the period changed by about 4 days/year but even these changes took a decade or two to be noticeable. Are you that patient?

So is there anything more active? Yes! There are about 20 Cepheid variables observable with telescopes of this type which show light variations of more than a magnitude and with periods of 10 to 40 days. The periods also show changes in about 50% of these objects. Even over one cycle the light variations range from 5% to 15% in a day, about 10 times as fast as Mira stars. Thus you see change every night.

Are there other objects. Of course. Every year or two there will be a bright nova visible to the naked eye and two to four per year visible through your telescope. There are also a few bright eclipsing variable stars - delta Librae every few days and BL Telescopii every other year. But except for BL special detection equipment with filters is necessary for the measures to be useful.

Cepheid requirements

A light curve of one of these Cepheids appears in Figure 1. This can be divided up into vertical steps in brightness, magnitudes, and horizontal steps for the phase. As with most pulsating variables the rise in brightness is faster than the decline. We need about 15 steps in the brightness and similar in the phase. But due to the fact that the periods are not an exact number of days most phases will be observed in a season but with fewer on the rise. The brightness steps are governed by the experience and accuracy of the observer - more of that later.

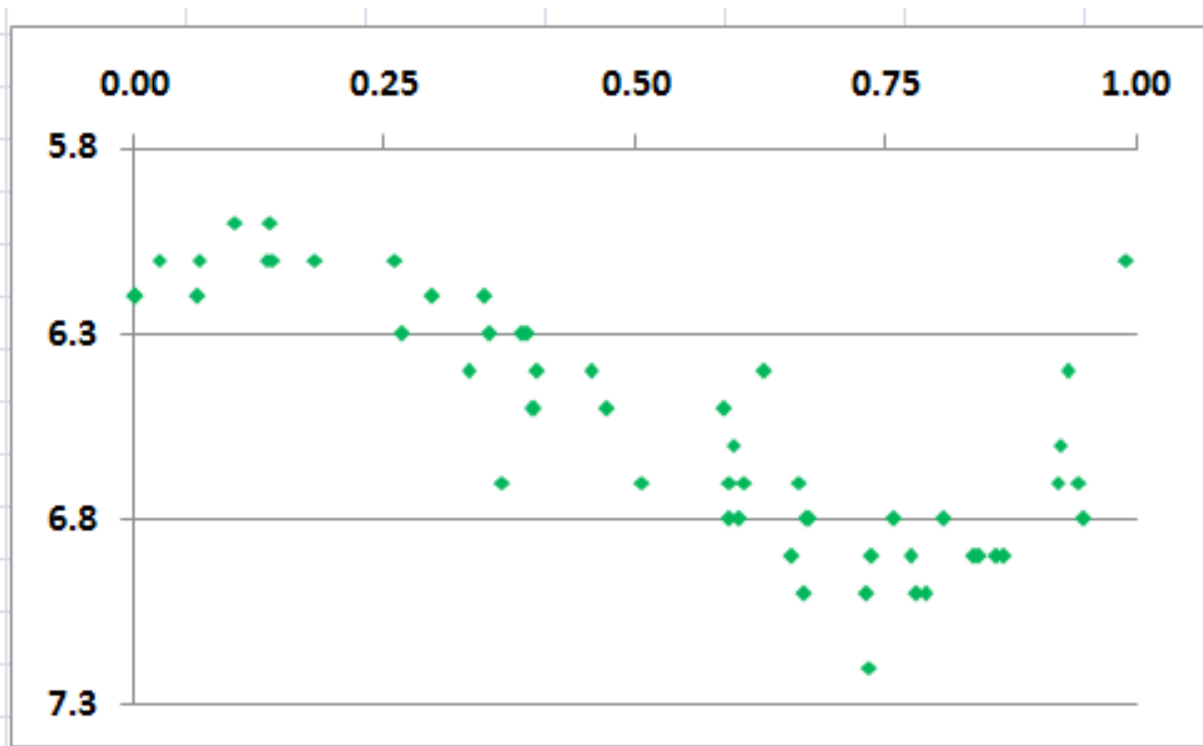


Figure 1. Visual measures of *R Muscae* over two seasons using a standard Mira comparison sequence with values to 0.1 magnitudes and steps of ~0.3 magnitudes. When fitted to a mean light curve derived photoelectrically using a least squares technique these will provide an epoch accurate to ~0.03-4 of the 7.510211 days cycle.

In the next two figures we show how these seasonal epochs are used to study period changes which arise from the reasonably fast evolution of these rather massive stars.

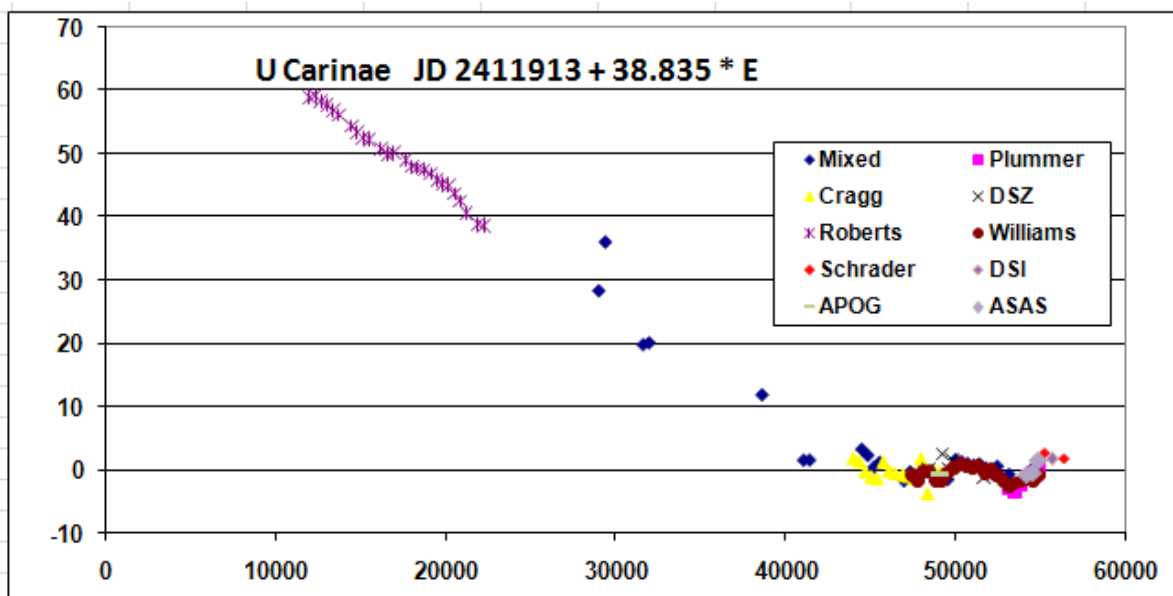


Figure 2. In this we show epochs from 1891 to 2014 on an annual basis with some gaps. They are fitted to an ephemeris based on the Julian date of the first observed maximum and the period as it is at present. The vertical scale shows days late + or early -, the horizontal one JD - 2400000. There was an abrupt change from a period of 38.753 days up to ~1970 to the period used here. There are also indications of a short term ~10 years sinusoidal variation. The observers are noted in the legend.

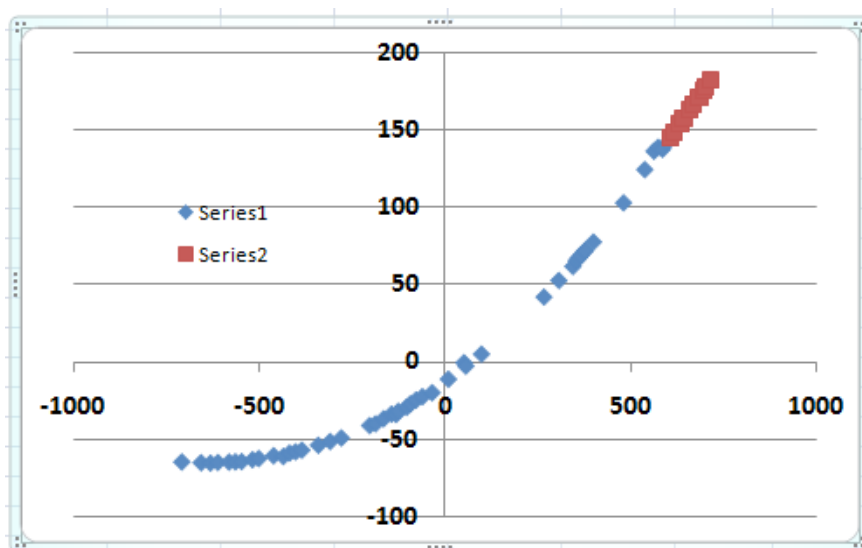


Figure 3. This shows an alternative method of plotting where the horizontal scale is in cycles based on the GCVS epoch and period of $JD\ 2433700 + 29.8\ \text{days}$. AQ Puppis shows a smooth evolutionary change as it crosses the instability strip in the Hertzsprung-Russell diagram. The red epochs are from ASAS3, the others a wide variety of observers. The period is now about 30.2 days.

This method of presentation is called an O-C diagram. The O(bserved) epochs are plotted against a C(alculated) set of phases based on the ephemeris quoted.

Observing Cepheids

Variable Stars South has prepared special visual charts for use in measuring these stars. They are meant to be used with a telescope with the more comfortable position - as compared to binoculars - providing better accuracy. Since most telescopes use a diagonal, the charts are reversed E/W but direct view charts are available. Comparison values are expressed to 0.01 magnitudes. As with any new skill it takes a little time to learn the techniques. A typical chart is shown in the appendix.

Only one measure a night is needed. Maximum cannot be determined with any one night's measures so don't try. A 3 to 7 day interval is probably best and the weather may well determine this. All times should be expressed in UT, not local or daylight saving time, to the nearest minute and then corrected to Julian dates. For our purposes we use the conventional 5 integer 4 decimal notation, 12345.6789, but if you submit your measures to the International Database they use the full version which uses 7 integers and began on 1 January, 4713 BC.

There are usually about 10 comparison stars on each chart with steps of about 0.2 magnitudes. Pick the two between which the brightness of the target appears to lie and then estimate where the target lies in this interval - half, quarter or third up or down. Add or subtract appropriately from the comparisons for your observed value. Record the time and value. These should be submitted to the Cepheid group after each month has ended.

Spreadsheet display

It is always interesting to present your measures in a visual format such as a spreadsheet. We show as Appendix 2 such a presentation of the observations for R Muscae to produce a phased light curve..

DSLRL measures

So far we have covered only visual measures. But Variable Stars South introduced the concept of measuring Cepheids with DSLR cameras in 2009 and this has been very successful.

What are the goals of this project?

As with all Variable Stars South projects the idea is to find out what the star is doing now, relate this if necessary to historical measures and try to determine what this tells us about the star at present. This may mean collaborating with other groups or using other measuring methods - spectroscopy is one - and finally putting it all together in a published paper.

The stars selected are based on two criteria. The first is an amplitude of more than one magnitude as

this makes it easier to observe visually. The second is period which is related to the brightness and mass; with longer periods the more the brightness the faster is the evolution and thus we expect more period changes.

Help and mentoring

This is available to all participants or prospective observers. The project leaders at present are Mark Blackford for DSLR measures and Stan Walker for visual measures - and hopefully some BVRI measures during this season.

Charts downloaded from the website will be much clearer than the appendix version.

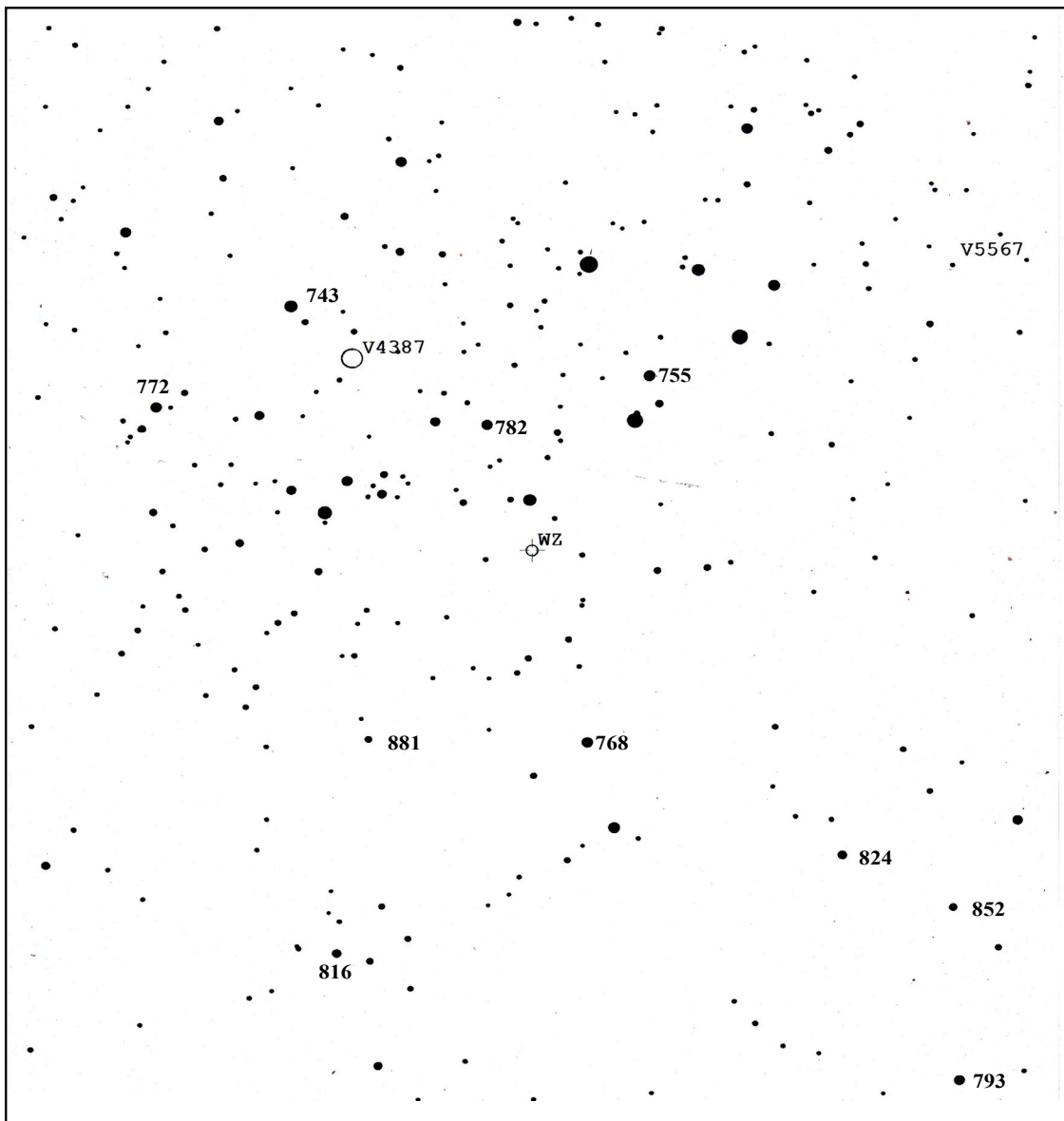
Appendix 1

WZ Sagittarii

RA 18 17 00 2000 Dec -19 04 43

Epoch 35506.629 Period 21.849708 days Range in V 7.45 - 8.63

Reversed chart Vertical scale ~2.0 degrees



This chart has been designed for visual observers in the Variable Stars South Bright Cepheid Project. The magnitudes are from Guide 9, based on the Tycho values as transformed to the standard V of the UBVRI system. Do not use any others as the magnitudes may not be reliable.

Appendix 2

Sample spreadsheet data for producing a phased light curve of R Muscae.

Phase = (Julian date - epoch)/period - INT((Julian date - epoch)/period).

Epoch	26496.28	
Period	7.510211	
Julian date	Mag	Phase
57091.06	6.8	0.757714663
57081.279	6.4	0.45535445
57073.288	6.3	0.391336409
57065.07	6.2	0.297092851
57043.28	6.5	0.395709654
57037.254	6.8	0.593335394
57033.274	6.2	0.06339023
57025.297	6.2	0.001236317
57023.31	6.9	0.736663191
57020.283	6.4	0.333611932
57013.29	6.4	0.402479637
57007.295	6.8	0.60423309
57000.288	6.8	0.671236667
56996.279	6.1	0.137430094
56986.3	6.8	0.808705774
56977.295	6.7	0.609671552
56970.265	6.8	0.673612632
56957.304	6.8	0.947828896
56945.333	6.3	0.35386569
56873.076	7.2	0.732697923
56856.094	6.5	0.471509788
56852.129	6.7	0.943561905
56850.065	7	0.668736071
56833.013	6.5	0.398227293
56823.063	5.6	0.073364384
56811.299	6.7	0.506963653
56780.072	6.2	0.349024548
56770.119	6.1	0.023762182

Julian Date	Mag	Phase
56761.251	6.9	0.842969791
56753.274	7	0.780815879
56744.319	6.5	0.58843926
56735.151	6.7	0.367701254
56733.144	6	0.100465087
56716.156	6.9	0.83847804
56709.293	6.6	0.924655512
56707.337	6.7	0.6642101
56704.299	6.1	0.259694168
56701.304	6.9	0.860903775
56699.329	6.6	0.597928474
56695.321	6.1	0.064255052
56694.248	6.7	0.921382901
56693.144	6.9	0.774383037
56692.257	6.9	0.656277167
56690.239	6.3	0.387576328
56688.342	6	0.134986887
56687.256	6.1	0.990383759
56685.307	7	0.730870411
56684.277	6.7	0.593723798
56681.166	6.1	0.179487767
56679.306	6.4	0.931824951
56678.24	7	0.789884865
56677.033	6.4	0.629170339
56674.319	6.3	0.267795672
56673.292	6.1	0.131048515
56672.312	6.2	0.000559505
56671.316	6.9	0.867940062

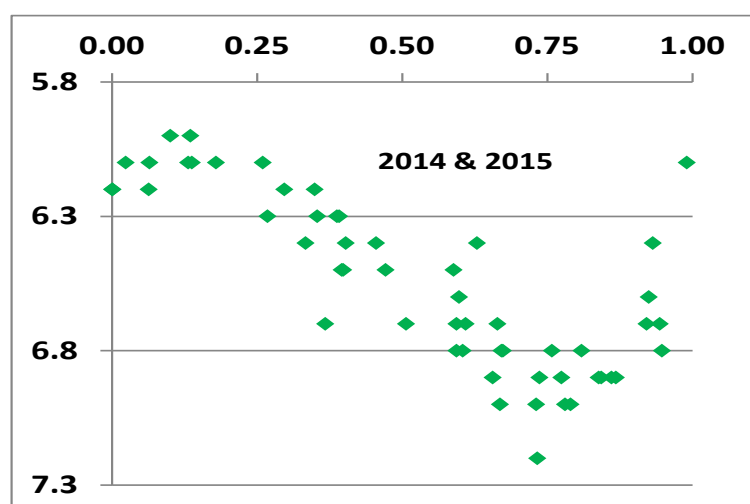


Chart of phased vs observed magnitude from above data. Notice that maximum brightness does not occur at phase 0.0. This indicates that the period has changed since the GCVS epoch.

A call for closer monitoring of BV Cen – Alan Plummer

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Late July through early August 2015 has seen the southern dwarf nova BV Centauri in outburst. What follows highlights some interesting features—of both the system and the data set—and I hope makes the point for closer monitoring. The system first:

BV Cen is located at (J2000)13 31 19.51 -54 58 33.6. The system's orbital period is 14.7 hours, the white dwarf mass is 1.24 solar masses, the secondary's mass is 1.1 solar masses, and the maximum accretion disc radius is 976,000 km (Kotko and Lasota 2012). Thanks largely to Albert Jones, the system has been well observed for decades, leading to the listing of an outburst period—though dwarf novas are never *truly* periodic—of 149 days (Kukarkin et al 1971).

In quiescence the object flickers, around 13th mag and sometimes brighter, and the outburst period is now *nothing like* 149 days. In fact, assuming none has been missed, the outburst prior to this last in August 2015, was in August 2013. The implications of this are raised in a previous article which looked at 54 years of data, and include a possible magnetic cycle, a recent and drastic reduction in accretion rate, and an unobserved classical nova explosion over a century ago (Plummer and Horn 2009).

The data set in the AAVSO data base is interesting also. (I have made a request for the recent All Sky Automatic Survey data of BV Cen, but so far it has gone unanswered. It is expected to be publically released in some months anyway.) Figure 1 is the raw AAVSO data from March 2012 until the end of the recent outburst. It contains some visual data that are hard to understand. To the eye the *quiescent* data shows a suspicious periodic peak with about a one year cycle – quite bright too. I made a request via the AAVSO to contact the observer contributing all those observations (pink in fig 1), as well as endless fainter-than observations (blue in fig 1), in order to find a way to make use of those data. What chart and sequence was used? What instrument? It was unsuccessful, and the observations must be disregarded—so far at least. Other visual data in fig 1 is black, and Johnson V is green.

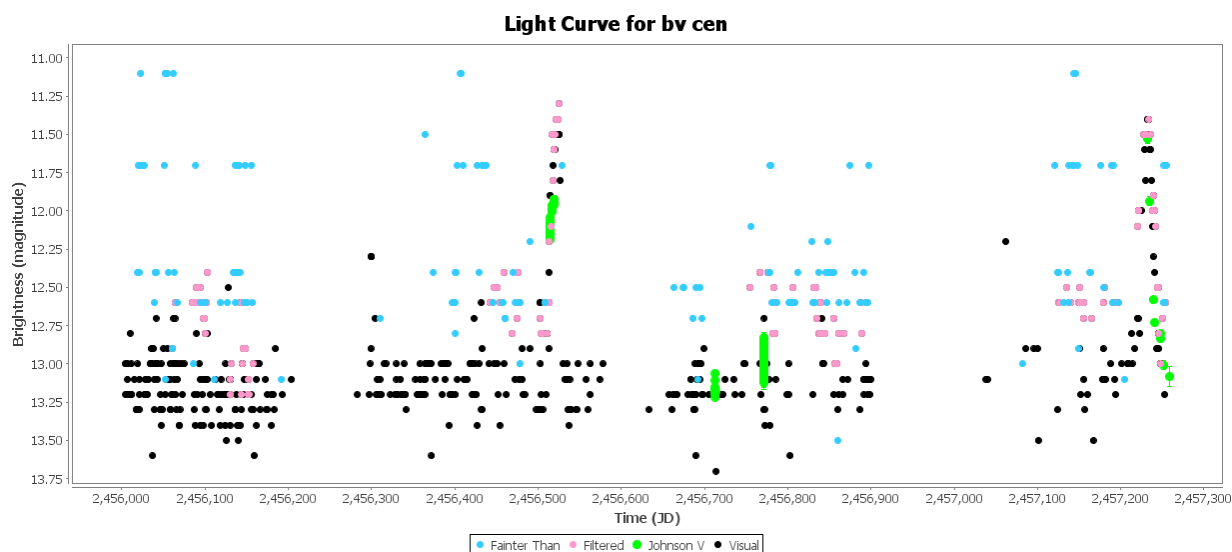


Figure 1. The raw AAVSO data from March 2012 until the end of the recent outburst. See text for color codes. Plotted with VStar

Figure 2 covers 100 days or so, and shows the recent outburst. Visual data from Rod Stubbings are in red, myself in black, and Johnson V data in green are from Terry Bohlson. Figure 1 observations in pink and blue are excluded. The red arrow represents Rod's estimate of quiescent level observations, (from un-processed data) prior to outburst. He was clouded out for the later part of the outburst. From my location, the entire event was compromised. High wind, cloud, and bright moonlight affect almost every observation. Different instruments needed to be used on different nights. The preferred instrument was the 40cm Newtonian, to cope better with the moonlight, but high wind often necessitated a 20cm telescope being used. Hence the 0.2 mag error bars on some observations. The error bars on Terry's V measures are reproduced in figure 2, but are smaller than the dots (mmm...).

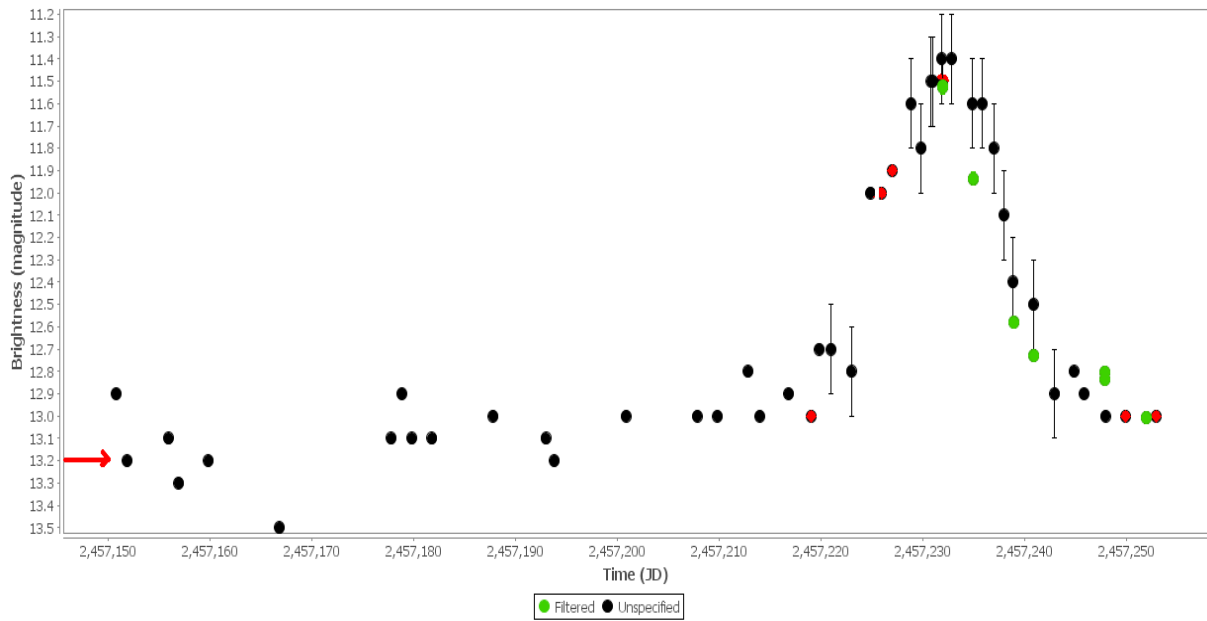


Figure 2. *The last 100 days or so, showing the recent outburst. See text for color codes. (VStar)*

Terry's observations are 6 nights of data through a V filter using 60sec exposures when it was at its maximum and 120sec exposures as it dimmed. The camera used is a ST10XME and the scope is a VC200L. The S/N was about 200. He measured the magnitude using the AAVSO's online tool called VPhot and an ensemble of comparison stars. The error range was about 0.02 mag.

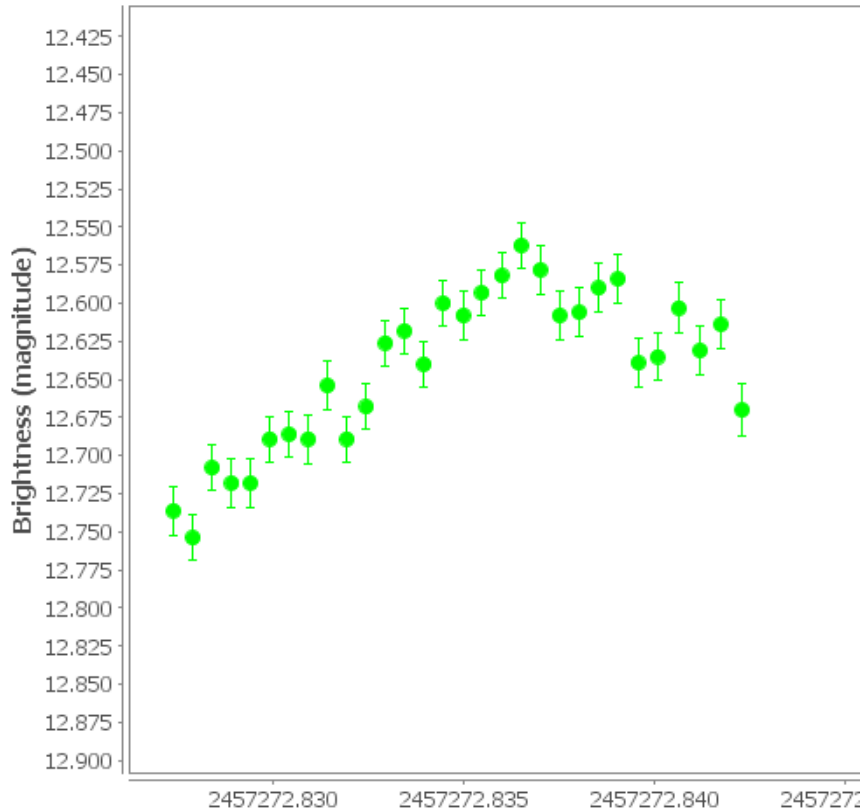


Figure 3. *High speed photometry from Rolf Carstens, taken 7/9/2015. Plotted with VStar.*

Figure 3 is fascinating. This recent photometry, taken after figures 1 and 2 were made, is from Rolf Carstens, and invites closer scrutiny of this object. It shows a clear and bright spike lasting 20 or 30 seconds unlike anything I can see in the pre-existing data. I note that Rolf used the same comparison star here that I often use. Other high speed measures in the data base, some visible in green in figure 1, show quiescent level ‘noise’, and one possible oscillation superimposed on the previous outburst. It’s worth pointing out that I disregard—so far—the possibility of the figure 1 observations in pink capturing similar short bright spikes, at every observation.

It seems that an intensive and coordinated campaign of visual and photometric observation of the BV Cen system could be interesting for the observers of the VSS.

References

- Kotko, I., Lasota, J.-P. (2012) A&A 545, A115
Kukarkin, B.V. et al (1971) General Catalogue of Variable Stars, 3rd ed. Nauka, Moscow
Plummer, A., Horn, P. (2009) JAVSO..37...23P

V854 Cen and two declines in 2015 – *Peter Williams*

V854 Cen in 2015

V854 Cen remains one of the most active of the RCB type variable stars, experiencing two deep declines during 2015. Neither of these events were, however, particularly well placed at the time of decline and each being not too far away from conjunction with the sun.

The first event commenced during early January when V854 was located in the predawn morning sky as it emerged from conjunction with the sun. A rapid fading followed as the star plummeted 7 magnitudes over the following 3 weeks, reaching a minimum near magnitude 14.5 at an average rate near 0.33 magnitude per day.

It remained close to this brightness with small variations for 13 weeks and then commenced an initial rapid recovery of 0.21 magnitude per day that saw it rise to magnitude 10 over an interval of 3 weeks. After this, the rate of recovery slowed to near 0.08 magnitude per day with V854 Cen rising the final 2.5 magnitudes to maximum in some 30 days. The final slower rate of recovery is a feature typically observed in many of the RCB stars.

The total duration of the first decline in 2015 was close to 190 days, or just over 6 months.

Following almost immediately its return to maximum V854 Cen again fell to near magnitude 8 but this turned out to be a false alarm, perhaps nothing more than a larger than normal pulsation cycle. History has shown that in the case of V854 Cen it typically ranges between magnitudes 7.3 and 7.8 but can fall to magnitude 8 without continuing into a deep decline. Should it be observed to fall below magnitude 8.5, however, we are almost guaranteed a decline onset is underway.

This brief stay at maximum came to an end in the latter part of October when V854 Cen again commenced a deep decline that saw it fall from magnitude 7.5 to 12 over 15 days, the decline rate near 0.30 magnitude per day being similar to that seen earlier in the year.

This second event for 2015 is still in progress at the time of writing and at this time of year V854 Cen becomes a difficult target, especially when faint, as it again approaches conjunction with the sun. Observations around this time and early in 2016 as it emerges from conjunction will help define the character and duration of the current event.

Figure 1 shows the light curve of V854 Cen during 2014 and through to early October 2015, the time of writing and close to the end of the current observing season. The seasonal gap is evident before and after 2014 data during which this star remained at maximum and the two declines of 2015 are readily seen. The light curve is courtesy of the AAVSO from observations submitted to the International Astronomical Database.

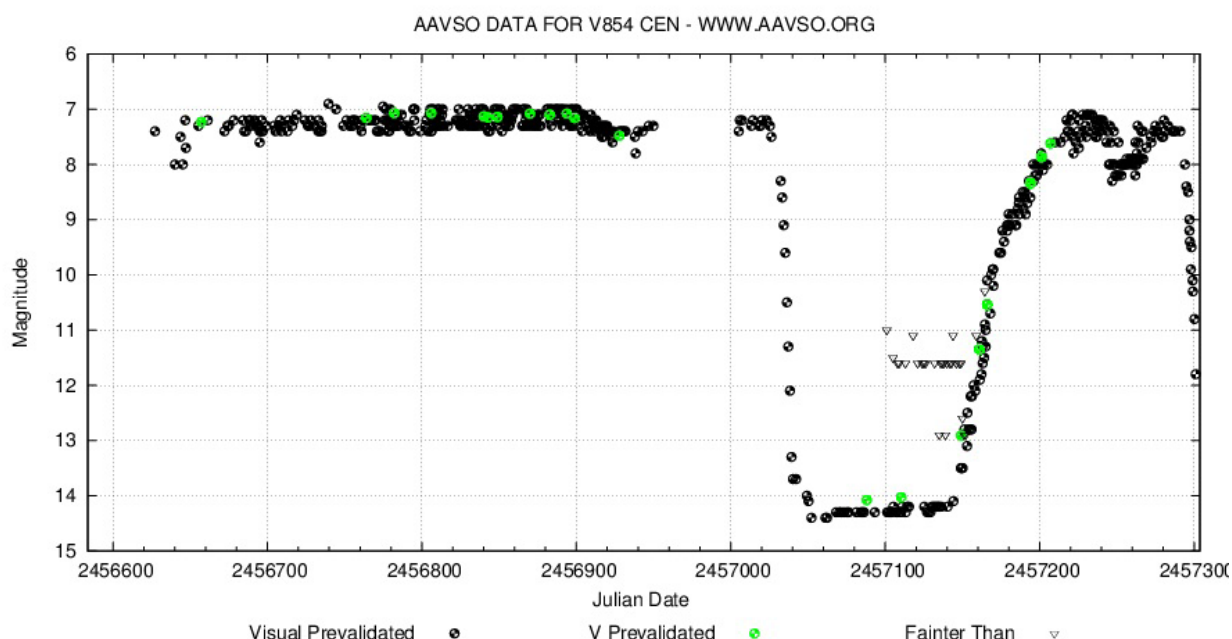


Figure 1. Light curve of V854 Cen through 2014 to October 2015. Data from AAVSO

V854 Cen – discovery, re-discovery and third time lucky

V854 Cen has the rather dubious distinction of having been “discovered” more than once. It was actually discovered three times!

Attention was initially drawn to this star when its variability was noted in 1964 during a photographic survey for southern variable stars conducted from South Africa by the Remeis Observatory Bamberg. It was designated the Bamberg Variable BV520, an apparently mundane small amplitude star near magnitude 10 and promptly forgotten as no follow up observations were obtained. This did, however, lead to its inclusion in the New Catalogue of Suspected Variable Stars with the designation NSV6708.

In 1971 its variability was again noted by New Zealand amateur Ron Welch but again there were no follow up observations and it continued to languish as one of the many thousands of unstudied faint, small amplitude stars.

Third time lucky for V854 Cen occurred in July 1986 when it was noted at magnitude 7 in nova patrol photographs taken by Australian amateur Glenn Dawes.

At this time there had been a number of changes within the amateur variable star community that facilitated the long overdue study of this star, notably the presence of Rob McNaught at the Siding Spring Observatory and the expert draughtsmanship of Mati Morel who had recently commenced the prompt issuing of detailed star charts for newly discovered and transient objects.

McNaught was a keen amateur variable star and comet enthusiast with ready contacts in the professional astronomical community while Morel’s charts allowed for prompt follow up observation by amateurs.

Through the efforts of McNaught, it was shown on survey plates this star had a large magnitude range between 7 and 15 while spectra obtained at Mount Stromlo pointed to an F type star with strong hydrogen lines and a carbon excess – possibly a previously unrecognised hydrogen rich RCB star. Also, the previously indicated small amplitude appeared the result of it being confused with a nearby field star when faint and also coincidentally being faint when survey images were captured.

Using Morel’s chart members of VSS began regular monitoring this star from the time of discovery by Dawes and in July 1987 were rewarded when it was observed to undergo a rapid and deep decline, duly reported and observed in real time, allowing timely and detailed spectroscopic study by professional astronomers. When a short time later a visual light curve was shown to McNaught at the 1988 Sydney NACAA all the pieces were then available to confirm this as a new RCB type variable and in 1989 the GCVS designation V854 Cen was allocated.

V854 Cen 30 years on

It scares me somewhat to realise that I have been monitoring V854 Cen for 30 years and it continues to be amongst my favourite variable stars. Within reach of 10x50mm binoculars at maximum but requiring the 30cm scope when at minimum, V854 Cen has been shown to be amongst the more active RCB stars currently known. During the 3 decades since regular observation commenced, it has experienced no fewer than 25 deep obscuration events, twice or more than the number of declines observed in other RCB stars.

If V854 Cen is not on your observing list, it should be – why should I have all the fun!

Astronomy projects for students – *Carl Knight*

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As an AAVSO and Variable Stars South member I take a particular interest in getting secondary school students interested in variable star astronomy.

I have recently had the opportunity to present astronomy projects for students to the science faculty at the high school my wife and my own children attended and that our youngest child still attends.

This opportunity was due in no small part to another student at the school who has been canvassing her science teachers since she started there for more astronomy since year 9 (12-13 years old).

Tessa Hiscox is a year 11 student at Freyberg High School. She is also a member of my local astronomical society, the Palmerston North Astronomical Society (PNAS). Tessa is a keen science student, particularly of astronomy. She encountered reluctance among the science teachers for astronomy projects, being told in effect that they are too difficult and require specialist equipment.

I have myself approached the school and made various suggestions for suitable student projects that I can assist with and received no encouragement either.

Tessa entered a science fair determined to do an astronomy project. With assistance from Dr Stella Kafka (AAVSO Director), we selected UU Muscae, a southern hemisphere Cepheid as a suitable target. We then started doing time series photometry in V and R and visual estimates.

Tessa is not shy and very enthusiastic. She gave regular reports to her teachers of progress. The evidence of an astronomy project getting real data and going somewhere significantly altered the mindset of the teachers. Tessa's mother, Lynn wrote a very flattering letter of introduction to the teacher at the school who is Tessa's biology mentor. These things in combination set up an opportunity for me to approach the school again.

Mairi Borthwick is the HoD Science at Freyberg High School. I contacted Mairi on a Monday and found myself at the end of the conversation having to come up with a presentation of astronomy science projects for the entire science faculty by the time of their weekly meeting on the Wednesday of the same week!

I immediately contacted a number of people, Stella, Stan Walker (Variable Stars South Director) and Jeremy Moss (PNAS president and ex-science teacher) among them. Via rapid fire email we came up with a number of ideas to present as potential projects to the teachers in my allotted 20-30 minutes.

I threw together a presentation based upon Tessa's project as this had generated plenty of interest already. I also included eclipsing binary and contact binary stars with animations, Miras and a science history piece on "the immutable heavens" using an animation of the passage of Barnard's Star.

When I presented an example classroom lesson on ionisation and recombination using Tessa's light curve of UU Muscae, I concluded asking, "Now can you imagine putting together an exciting lesson plan based on that?" An excited teacher called out, "How could you not?!"

I concluded my presentation on time and asked, "So how might we, AAVSO, VSS and PNAS, help you?"

The science staff were very interested in seeing real rather than contrived data. The 20-30 minute talk I told my boss I'd be away from work for blew out to the full hour leaving the staff to conclude their scheduled business in the last two minutes! The question time took up most of the time and I had to apologise and make the excuse that I needed to return to work!

We discussed the curriculum, where data might be obtained to help teach the curriculum.

"What data could we get to teach about black holes?" BL Lac object light curves spring to mind.

"How about exo-planets?" What about MicroFUN or an exo-planet transit light curve such as that obtained by Sergison? (Sergison, D. (2013). High precision photometry: Detection of exoplanet transits using a small telescope. *Journal of the British Astronomical Association*, 123(3))

"We teach nucleosynthesis, there's that star somewhere near the Southern Cross, what's it called?" Eta Carinae. "Yes, that's it. Is there something we could look at when teaching about nucleosynthesis?" You could get light curves for highly evolved stars and talk about how their behaviour is different to when they were less mature and about how they've moved through different burning stages and moved off the main sequence.

"Why are supernovae needed to make bigger elements?" The slow neutron capture process stops at Bi because it captures neutrons one of which decays to a proton giving Po which in turn by alpha emission becomes Pb and you need a rate of neutron capture that is faster than that alpha decay by Po to get any further and that only occurs in a supernova. (By the way, I was supposed to avoid more advanced topics, but the teachers raised all sorts of more advanced topics themselves so I'm off the hook for that one!)

I mentioned the opportunity to "publish" (excitement) in a "peer reviewed" (swoon!) journal and that led to some of the most animated discussion.

I had the opportunity to talk to one of Tessa's teachers as I left. He said it had made a huge difference that there had been an achievable project, with follow through on promises made as so often those things fail and the student is left disillusioned and reluctant to engage again.

We also discussed the teachers' perspective when approached by someone like myself. This leads me to the all important conclusions section.

Conclusions

The conclusions below are taken from the feedback received from the teachers as well as from emails and discussions with Tessa and her mother.

- Don't expect teachers to leap at the opportunity for astronomy projects. They are very busy and probably wary of what is being offered. It would be very useful for the AAVSO, VSS, RASNZ or the local society to provide an information pack to teachers to help establish a working relationship. I suspect that word of mouth once a good impression is made will also lead to opportunities beyond the first school approached.
- The Freyberg science teachers who participated in the presentation Q&A clearly did not know what is potentially available to them. Lynn, Tessa's mother notes, *"Her very enthusiastic biology mentor at school didn't see how a physics science project could be done by a student under her own steam. This is a v [sic] happy outcome."*
- We should take the time to find out what astronomy is present in the curriculum and tailor projects we offer to that curriculum where possible.
- The teachers were particularly receptive to the idea that they could get REAL data to work with – from raw images as I showed them (V and R images of UU Muscae), to the reduced magnitudes in a file – to then analyse themselves with students.
- The idea that their students could get something published and even peer reviewed with some assistance was a real game changer. I believe we should ensure this is mentioned when presenting what we can offer to schools.
- "Do we have materials to show the teachers what to do?" - this is my paraphrase of a number of

questions. “Powerpoints” were requested, but I believe we could make the material we develop for our own membership available so long as this is backed up with support and mentoring this should prove adequate. We should be open to addressing feedback regarding ease of use in a teaching context if we are going to help teachers and students.

- AAVSO, VSS, RASNZ or local societies should consider endorsing members who act as mentors to students, effectively an acknowledgement that this person is someone we know and whom we trust to mentor a student in astronomy. In my case this was implicit in Ian Cooper (past PNAS president) putting Tessa in touch with me. For reasons of safety for all parties, I believe this endorsement should come with some accountability back to a parent body. We should probably inform schools that if a person offers to mentor students in astronomy projects they can expect that person to be able to show a connection to and endorsement from “us” (whether RASNZ, VSS, PNAS or the AAVSO). We should provide a means by which schools or parents can check that endorsement.
- We should require our members to involve the parents of the student, and teachers should be made aware that this is a requirement. As a parent myself I want to know what my children are doing and who they are involved with. Lynn, Tessa’s mother, said, “...*your initial email explained our visit clearly and was reassuring as I hadn’t met you.*” And, “...*my [Lynn’s] involvement was required to accompany her [Tessa].*” Lynn is referring to the fact that I insisted that if Tessa was going to come out to the observatory that it must be with a parent. Lynn further wrote: “*A welcome email to the parent as well as the teenager at the point of first contact with the Astronomy group. With info and outlining the aim of including/ developing young people as Astronomers [sic], which would normalize their presence in the group and reassure the parents. This activity involves meeting with older blokes at night!*”
- Tessa notes that in considering an astronomy science project there is a “*more advertising/ presence*” required.
- Regular contact with and encouragement of the teacher(s) and the student(s) is essential. In Tessa’s case I kept her posted with the photometry in graphical format so she could see for herself that we were getting meaningful results.
- We should expect some bumps along the way in our relationship with schools, teachers and students. Thus far I have experienced something of a “honeymoon” phase. There will be glitches, a necessity to set expectations to something achievable and a period of discovering what that even might be. Beyond that I am confident we can achieve more than has been done to date.

The icing on the cake

Tessa’s UU Muscae project presenting the discovery, history and utility of Cepheids and standard candles with her light curve of UU Muscae was given a Distinction Prize in the science fair held in August 2015 in Palmerston North. It was the first astronomy science fair project that any of the organisers had seen in many years.

Fantastic result for a budding future astronomer!

I hope you feel encouraged as a membership to attempt to engage teachers and students. Let’s learn, share, adapt and encourage one another in providing an ability for teachers and students to do real astronomy.

Distinction for student Cepheid project – *Carl Knight*

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Tessa Hiscox (right) and her mum with Tessa's prize-winning high school astronomy project

Tessa Hiscox is a Year 11 Student at Freyberg High School, Palmerston North, New Zealand. Tessa entered in the August 2015 science fair in Palmerston North. She was determined to do an astronomy project. With some help from Carl Knight and AAVSO Director Dr. Stella Kafka, a suitable project was found. Tessa's project was the Delta Cepheid star UU Muscae.

Her project covered the discovery, history and utility of Cepheids as standard candles. She used V and R photometry obtained at Carl's observatory in the Rangitikei and her own visual estimates to show the pulsation period of UU Muscae. She was then able to calculate a distance to UU Muscae using the period of the star and the Cepheid period-luminosity relationship.

Tessa's was the first astronomy entry that the science fair organisers had seen in many years. She won a distinction prize for her project - ironic given that when she announced her intention to do an astronomy project she had been told that astronomy projects were too difficult and require specialised equipment!

Tessa has been invited to write a short paper on her research with Dr. Stella Kafka for the Journal of the AAVSO and Tessa will be presenting her project to the Palmerston North Astronomical Society early in 2016.

The project has been instrumental in helping Tessa choose a University and a course of study. She has decided to go to Canterbury University to study Mathematics, Computer Science, Physics and Astronomy.

And that as they say is the icing on the cake!

For some time now I've been advocating the use of small cheap GPS units for timing purposes because I believed them to be capable of millisecond accuracy. Now I know this is not the case.

I've had some discussion with VSS member Robert Jenkins and Blair Lade, a timing expert at the Australian Defence Science and Technology Organisation, which throws light on how these small GPS units work and unfortunately it turns out that they are probably accurate only to the last second.

Blair points out that while some GPS units have pulse-per-second (pps) output, many, and this includes my \$25 unit, do not, but instead they output only a string of data corresponding to the National Marine Electronics Association (NMEA) standard which includes timing information. In the absence of pps, this output is the time of the last second.

There are more problems if the GPS is connected via USB-to-serial instead of direct serial and, with Windows, it can depend on which OS you are using and whether the computer is doing a lot of processing.

A GPS with pps output into a serial port of a computer (not Win 8) with NTP (Network Time Protocol) would be best, says Blair. Failing that a GPS with pps output into a USB-serial converter. Otherwise just use the internet time service provided by Windows but connected to your nearest ntp pool server. In the Oceania pool 66 are in Australia and 19 in New Zealand (<http://www.pool.ntp.org/zone/oceania>). My nearest is in NZ, 3000 km away, so I'm now scouring the internet for a cheap GPS with pps.

Windows users should set their internet time server to pool.ntp.org. To set the time manually Windows users can set their time using the following at a command prompt (run as Administrator):

```
w32tm /config /syncfromflags:manual /manualpeerlist:"0.pool.ntp.org 1.pool.ntp.org 2.pool.ntp.org 3.pool.ntp.org"
```

Blair has provided for VSS the following article on time and time servers.

A users guide to time, NTP servers and software (v1.2) – *Blair Lade*

Glossary

Atomic Clock	'The' reference for our time see http://www.nist.gov/pml/div688/grp50/primary-frequency-standards.cfm
Client	As far as NTP goes, your computer is the client (recipient) and the host is the 'server' Your computer can also be set up to be an NTP server for other computers on your network but at a 'higher stratum' level (ie less accurate)
GPS	Global Positioning System (US owned) time from atomic clocks on board the satellite that are synchronised to the atomic clocks on earth http://en.wikipedia.org/wiki/Global_Positioning_System
Host	from our perspective, it is the network address that we wish to connect to; ntp.internode.on.net is the host address of Internode's time server
IE8	Internet Explorer 8, no longer supported by Microsoft, use Google Chrome, Mozilla etc instead.
Latency	How long it takes a computer to do something, low latency is fast. Fast is good. http://en.wikipedia.org/wiki/Latency_(engineering)
NIST	The organisation that keeps THE reference clock for the US (and most other countries) http://www.nist.gov/pml/div688/

NTP	Network Time Protocol, used by everyone to set the time on your computer from a time server http://en.wikipedia.org/wiki/Network_Time_Protocol and http://www.ntp.org/
Ping	http://en.wikipedia.org/wiki/Ping when we 'ping' an internet address we get an echo and can confirm if it is 'alive'. 'Pinging a time server', we usually ask it for the time using NTP. If we ping it a lot, the owners will get annoyed and disconnect you!
Pool server	1.au.pool.ntp.org is a 'pool server' it randomly generates addresses for Australian time servers that we can use.
Stratum level	indicates how many 'jumps' from the accurate clock the time server is. See http://en.wikipedia.org/wiki/Network_Time_Protocol
Stratum 0	Atomic clock or GPS satellite
Stratum 1	GPS receivers get their time from a GPS satellite (Stratum 0)
Stratum 2, 3	What you commonly connect to (Time servers) to update your computer's time.
Stratum 4	What your computer becomes if it is set up by a Stratum 3 time server and used to server NTP to other computers.
Time	http://en.wikipedia.org/wiki/Time
Time Server	A network connected computer / box that has a connection to a very accurate time source such as a GPS http://en.wikipedia.org/wiki/Time_server
TZ Edit	Allows you to change the start and finish of time zones in Windows boxes http://www.softshape.com/cham/manual/tzedit.htm
W32TIME.EXE	a blog about why Microsoft's time is not accurate http://blogs.technet.com/b/askds/archive/2007/10/23/high-accuracy-w32time-requirements.aspx
XP	Operating System (OS) for computers, no longer supported by Microsoft

Links and Software

<http://www.ntp.org> THE home of NTP, Network Time Protocol

<http://www.pool.ntp.org/zone/au> the home of Aust time servers

<http://symmtime.software.informer.com/4.1/> free, Symmtime, good for NTP and also lots of different clocks

<http://www.gpsinformation.org/dale/nmea.htm> NMEA serial string (from GPS) info

<http://www.visualgps.net/NMEATime/> NMEA Time, this is the ONLY s/ware that I have found that works properly with a GPS and the 1pps, needs a licence (I could assist) however, most GPS receivers don't output all the NMEA strings required.

Also works well with NTP servers.

<http://www.visualgps.net/> VisualGPS visual display of GPS status

<http://windows.tucows.com/preview/348480> free, windows time synchronizer, this is not the 'MS Windows' one, this works for NTP servers.

<http://www.fountainware.com/Products/TimeCalibrator/index.htm> this is used to find out how much your computer drifts, will also set the time via NTP and 'tune' your pc's clock (might explain later)

<http://www.kaska.demon.co.uk/> free, Tardis 2000 does NTP ok, but doesn't do GPS very well at the moment.

<http://forums.whirlpool.net.au/archive/646165> a forum about OZ time servers (limited info)

<http://www.windowstimestamp.com/> this is the microsecond timing project, bit difficult to set up and not really needed for us. But included for completeness.

Abouttime www. <http://abouttime.software.informer.com/4.8/>

WTClient www. <http://www.file.net/process/wtclient.exe.html>

TZedit <http://download.microsoft.com/download/5/8/a/58a208b7-7dc7-4bc7-8357-28e29cdac52f/TZEDIT.exe> (allows editing of Windows time zone info)

Windows Time Synchronizer - built into Windows

Lady Heather <http://www.ke5fx.com/heather/readme.htm>

Various servers you can use in Aust

ntp.internode.on.net (Adelaide)

ntp.ade.connect.com.au (some forums suggest this isn't very accurate sometimes)

0.au.pool.ntp.org these are randomly generated lists of Aust time servers.

1.au.pool.ntp.org

2.au.pool.ntp.org

3.au.pool.ntp.org

I have found that 0.au.pool.ntp.org is a bit 'flaky' so use the next one.

Using NTP to set your computer's time

First thing I'd do is download and install time calibrator from <http://www.fountainware.com/Products/TimeCalibrator/index.htm>

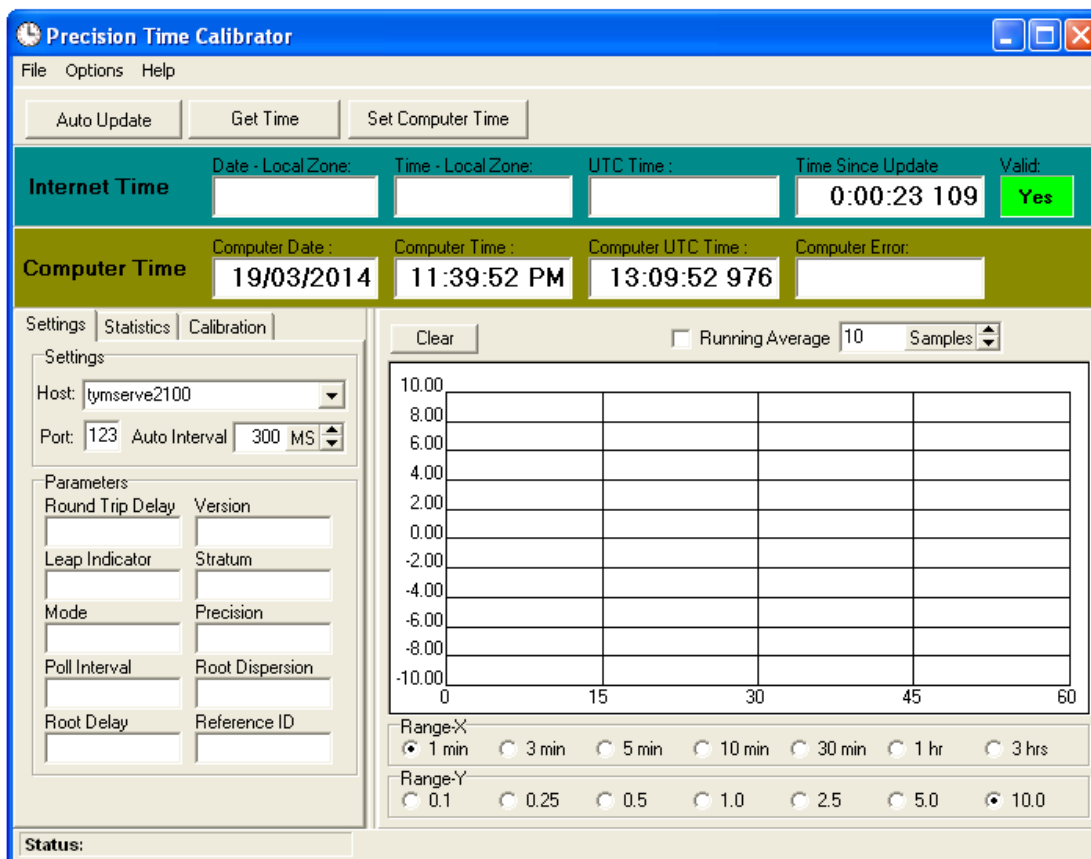
If the link doesn't work and you are using Internet Explorer 8 on XP (both are no longer supported), then use Mozilla, Google Chrome or anything but IE8

Run time calibrator

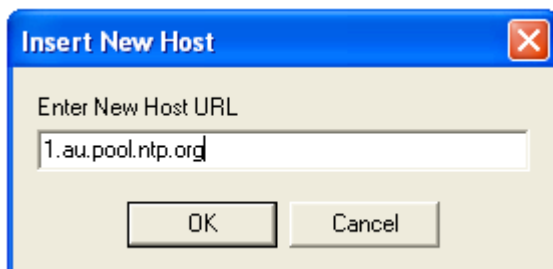
Under options, click on edit hosts

Select each one in the list and delete using the X, all the (American) servers as the latency with them is too much for our use. (If you want to you can leave a few and we'll try later and see just what that latency is and if they work properly or not.

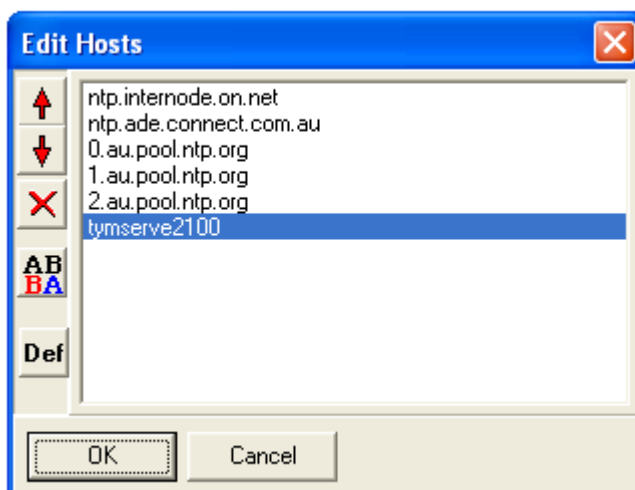
See [http://en.wikipedia.org/wiki/Latency_\(engineering\)](http://en.wikipedia.org/wiki/Latency_(engineering))



Now click on the AB button add a few of the time servers from the lists above



Once you have put a few OZ servers in the screen should look sort of like this.



The highlighted one is my own time server, so you don't need that.

For the time being, using the arrows, put 1.au.pool.ntp.org at the top of the list,

Click OK and get back to the main screen.

Under 'Options' click on 'Save Settings' or all your editing will have to be done again.

If you have an internet connection, then click on 'Get Time'

You should see some numbers fill in on the screen and a Green YES should be showing.

If good, do it again and then click on 'Set Computer Time'

This will set the time of your computer to the time on the pool server.

Click on 'Auto Update'

Lots of numbers should be flashing showing the server time, and the computer's time. On the bottom of the graph, click on the 1 hr radio button on Range X and also on the 0.1 radio button on the Range Y

You should now see a red line slowly being drawn on the graph.

The vertical axis is Your Computer's time error in seconds.

This is showing how your computer's time is drifting with respect to the Pool server we selected in Host.

You may want to slow down the rate at which you 'hit' the pool server, using the arrows or type in the Auto Interval, change it to 2000 (mS), this will query the server every 2 seconds,

If you 'ping' it too often, they will get pissed off with you and terminate your connection!

If you get lots of RED valid NOs then choose another pool server and see if that one is any better.

The 'Round Trip Delay' is how long it takes to get the time back from the time server, It shouldn't affect the actual time setting as the NTP protocol is pretty smart and corrects for this, but using a local time server in Aust with a low latency is always the right thing to do.

While it is running, you can click on another 'host' and see how accurate that time server is compared to the other servers, if you left an American server on there, click on that and see how that fares..

After a while, you may see the graph slowly rise or fall or suddenly jump. This is normal, the jump could be Windows resetting the clock!

Now for some real fun!

On the lower RHS of your computer should be the Windows time display, double click that, and under the Internet Time tab, you can make Windows update the time on your computer when ever you want to.

Try setting the server in 'Date and Time' to time.windows.com, click apply and then update.

Did the graph go off scale?

If it did, change the RangeY to something like 2.5 or even 5 or 10 to get the graph back on scale.

Select different Servers in the Windows Time and Date, click 'apply' and then 'update'.

You may have to click update a couple of times (it is Windows after all!).

You should be seeing the graph jump all over the place.

Try clicking 'Set Computer Time' in Time Calibrator. That should bring it back to the middle again. (funny about that).

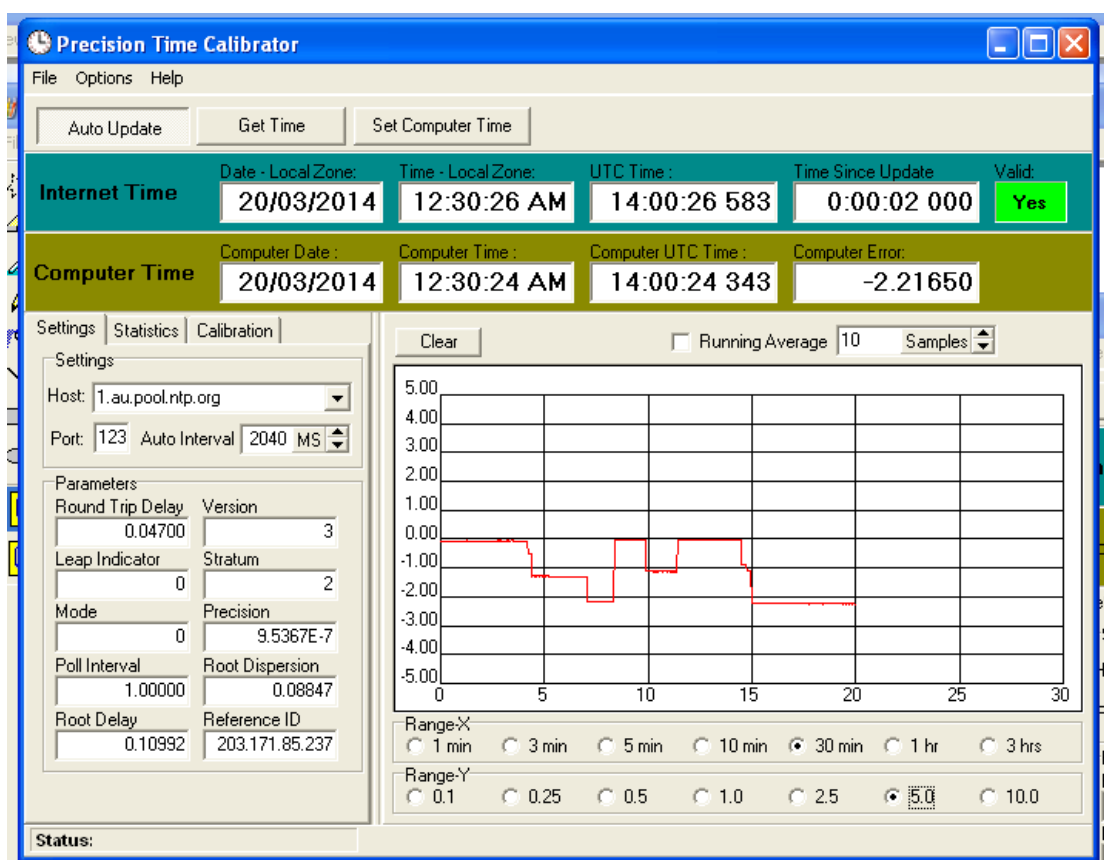
Play around a bit and you'll see all sorts of poor timing from Windows.

This is why I say that you can't use nor trust MS Windows software to set the time on your computer for variable star work.

As to why Microsoft's w32time.exe isn't accurate, you are directed to a blog <http://blogs.technet.com/b/askds/archive/2007/10/23/high-accuracy-w32time-requirements.aspx>

If the graph gets too messy, click on 'Clear' and the graph will start again..

I've seen 3 seconds of error often.



Ok, now that your acquainted with Time Calibrator (the test tool), and Windows Time and Date, turn off the 'Automatically synchronize with an internet time server' in Windows Time and Date

This should stop Windows from trying to set your computer's time.

It may not, so there are other ways to turn it off.

If you do turn this off, you must use one of the other applications that sets the time via NTP, otherwise your computer will not have it's time set.

You must set another one up to run automatically or turn this back on later otherwise it will turn to tears.

You can now install other time setting software from the list and have some fun checking how well they do their setting, you'll need to edit time server 'hosts' to ones that are avail in Australia as we did before in time calibrator.

You can run Time Calibrator for hours, but please don't ping time servers too often, we don't want to get banned from doing this.

Precision Time Calibrator won't set the time on your computer automatically, it is used as a testing tool only. As you get the feel for how other software works and sets the time, pinging a time server once a minute is probably enough.

A list of software for time setting from the NIST site <http://www.nist.gov/pml/div688/grp40/softwarelist.cfm>

It really depends on how much your computer's time drifts.

Try running your other software, cameras etc at the same time and see how your PC performs, you might need to set the time more often.

I use Symmtime <http://symmtime.software.informer.com/4.1/> quite often as I can set clocks to both UT and local time zones.

Symmtime can set the time automatically but it doesn't have to, it can just be used to show lots of clocks.

Read the help files on how to set up time servers etc, if you have any trouble, let me know.

Windows time synchronizer <http://windows.tucows.com/preview/348480> works pretty well as well.

Using a GPS to set your computer's time.

You need NMEA Time software <http://www.visualgps.net/NMEATime> (free for 30 days), a GPS that outputs NMEA time strings via a serial port with the 1pps (pulse per second) and you need to have a serial port available on your computer. A USB to serial adapter will do.

The GPS needs to have the 1pps signal connected to pin 6 of the serial connector. (I may have to sort this out for you.)

Once you have all this, you need to go into the device manager in the control panel and disable the ball point device under mice and other pointing devices.

It won't effect your computer.

If you don't and boot your PC with the GPS connected, Windows will think you have a ball point device connected, it will see the 1pps and the ascii NMEA serial strings and load the ball point driver which will make the cursor jump all over the screen. And it will really piss you off, (you have been warned!)

Once NMEA Time is installed and loaded, it can be configured to have either NTP or a GPS as its time source.

There are some issues with using it with a GPS, the GPS needs to output several NMEA strings and most GPS it seems, don't do all that it requires.

If you are using Windows7 + read this.

Currently NMEATime runs as a normal application in user mode. Newer versions of windows consider setting the PC clock an administrative activity and will not allow applications running in user mode to set the clock.

To allow NMEATime to run and set the PC clock, you must run it in "Administrator" mode. To do this, find the shortcut that starts NMEATime and right click on it. Select the "Properties", click on "Advanced" and check "Run as administrator" checkbox.

NTP from Meinberg <https://www.meinbergglobal.com/english/sw/ntp.htm>

It's not the hardest thing to install, but it does take a bit of work to get it going.

It can set the time on your computer accurately from time servers on the internet.

It can be used to set the time on your computer from a GPS that has the 1pps on the DCD line of the serial port.

Meinberg also has an NTP monitor <https://www.meinbergglobal.com/english/sw/ntp-server-monitor.htm> that checks everything and gives you stats.

There is a version of NTP ported for Windows, OSx, Linux and RPi.

Go here first <http://www.satsignal.eu/ntp/setup.html>

There are links and lots of text on how to set it all up.

CCD Targets for October to January

Here is the list of targets for October through January. It is culled from Pribulla, T. *et al*, 2003CoSka__33__38P and a southern subset of their (much more detailed) catalogue, filtered for CCD mags ($V_{\max} \geq 10$). The paper, full catalogue and southern catalogue (with much more information than presented below) are in the project's Dropbox folder. Go to Papers\Pribulla Targets. You can find out a lot more about each target at the AAVSO's VSX portal, www.aavso.org.

Star	HJD0-2400	Per	RA2000	DE2000	Vmax	Vmin
	d	d	h:m:s	d:m:s	mag	mag
CN Hyi	48500.1	0.436968	00 25 24	-46 55 27	10.47	10.59
V535 Ara	45920.1	0.283997	01 11 04	-79 10 54	13.2	14.1
RR Cen	48389.69	0.379924	01 16 38	-39 42 31	10.27	10.8
V353 Vel	48500.16	0.234727	01 42 26	-45 56 54	12.7	13.2
OQ Vel	48500.28	0.30666	01 50 23	-46 58 28	12.5	13
V386 Pav	48500.27	0.311784	04 14 18	-46 26 57	11.4	12.1
V701 Sco	48072.96	0.285464	05 18 32	-68 13 33	10.8	11.4
V870 Ara	48500.18	0.432567	07 33 38	-50 07 25	10.7	11
UZ Oct	48405.58	0.264985	08 18 07	-45 23 30	12.55	13.4
V1084 Sco	48500.08	0.516285	08 40 06	-42 49 44	10.49	11.07
BM Phe	48500.2	0.38958	09 47 42	-53 28 18	12.43	13.1

If you want to work on these targets, please contact me and I'll send you an invitation to share the VSS EB-EW Dropbox folders. There you will find project information, useful papers, and our data for each target under observation. Yours will be added, and you will be a co-author when we publish.

Also if you're unsure about how to do any of this work, email me and we'll discuss it. But first, as a background, do read the pages about the EB-EW Binaries Project on our website (<http://www.variable-starssouth.org/projects/projects/eb-and-ew-binaries-project>). You will also find the pages on the EA Binaries Project useful, as well as the article on targets in the previous *Newsletter*.

Q & A

From time to time in lives our we all have questions about our hobby, even the experts but especially the newcomers. We may not have anyone nearby whom we can ask when we don't understand something or don't really know the definition of some term so in each newsletter I will try to publish at least one question and answer. For this issue Tom Richards has provided us with a detailed definition of the term 'epoch'.

What is an epoch?

Q: When reading about various stars, epochs seem to pop up at various times for no rhyme nor reason as far as I can tell. What determines the choosing of an epoch?

A: In general, an *epoch* is a defined point in time from which events are measured. January 1st, 1 AD is for example the epoch from which our civil dating system is measured (omitting year 0!). Astronomers prefer the Julian date system, a count of days (positive and negative including 0) whose epoch

is noon UTC on January 1, 4713 BC.

Another use for *epoch* in astronomy is to pin down the moving celestial coordinate system of right ascension and declination. This coordinate system has its “zero point” at the *Vernal Equinox*, one of two points where the ecliptic crosses the celestial equator. So that is RA 0.0, Dec 0.0 degrees. But the vernal equinox moves along the equator due to precession, slowly changing the RA and Dec of stars. To fix that, astronomers define a particular epoch, called an *equinox* since it’s telling us where the equinox is at that time; and then define the position of celestial objects according to the coordinates they had at that epoch. Currently we use J2000, defined as 2000 Jan 1 at 12h Terrestrial Time. So *Equinox J2000* is the currently used epoch for measuring RA and Dec of stars (think of it as the position the Vernal Equinox had at that moment). However if you’re going to get a “goto” telescope to point to a star, and it has its J2000 coordinates in its database, it has to correct for precession to the current equinox (the coordinates the star has at the moment, taking precession into account). That moment, the moment of observation, is called its *equinox of date*.

Yet another use of *epoch* in astronomy is to refer to a zero-point in time from which a recurring event can be calculated. For example, even if we know the period of an eclipsing binary, that doesn’t help us to know what position in its orbit it currently occupies right now. So an astronomer chooses more or less arbitrarily the time of a particular minimum in its light curve, and calls that its epoch (normally expressed as a Julian date). Then, if we know its epoch and period (together known as the binary’s *light elements*), is it easy to calculate when the next eclipse can be seen, or where it is in its orbit (relative to our line of sight which is where the eclipses occur) at a given moment. For regularly pulsating variables like RR Lyraes, the time of a maximum is chosen as the epoch.

Unsurprisingly, astronomers are often a bit lax in this use of *epoch*, referring to any minimum or maximum. So it’s a good idea to refer to the epoch used in light elements as the *zero epoch E0*.

In a similar way, if you are to state the six *orbital elements* that define the orbit of a planet, or one star around another, you must also give an epoch, from which the position of the planet in its orbit can be calculated using the orbital elements. That is known as the *mean anomaly at epoch*, defining the position of the planet in its orbit at that epoch.

A weekend in Hawaii – *Phil Evans*

phil@astrofizz.com

In August this year I attended Swinburne University’s Astrofest convention at Waikoloa on the Big Island of Hawaii. The meeting was for present and past students of their online astronomy programme.

In 1999, while online education was still young, and so was I, I signed up for a course on the solar system from Swinburne university in Melbourne. It was, as far as I can tell, the first such course to be made available online. Nowadays almost all universities with an astronomy department offer some kind of online course.

For someone who finished his formal tertiary education in 1969 the prospect of more university studies was a bit daunting but I was keen to learn more about what had been up until then just an occasional hobby. I didn’t have a telescope but I did have a few books and magazines. Actually, I thought I already knew a lot of astronomy but the first semester soon disabused me of any such notion. I really had little idea of how much there was to be learnt about the solar system, and I was surprised at the extent of my desire to learn more.

After that first semester I converted to the full master’s programme. It was through coursework and tests, not by thesis, and consisted of twelve one-semester long courses. At the time I had a business to run which kept me busy for a lot more than the regulation 40 hours a week, so rather than try to take several courses concurrently I took the slow route doing just a single course per semester. Thus it took me until 2004 to finish and get my MSc (Astron).



I took a 'selfie' in the mirror of the Keck II telescope. Each of those hexagonal primary mirror segments is 1.8 metres across.

It turned out to be one of the most gratifying times of my life and I thoroughly enjoyed the whole learning experience. The lectures were presented to us on a CD, there were recommended texts for each course but the bulk of the work consisted of the online newsgroup – participation was mandatory – in which we had to initiate discussions, ask questions and answer other students' question. There was a tutor allocated for each course and they could be anywhere in the world. They set the essay and project topics and generally kept the online discussions on the right track.

Being post-grad students meant that we had full access to the latest journals and I did most of my learning by reading published papers, though the text books came in handy at times.

My fellow students, at that time, were a real mix. The majority had either a BA or a BSc but there were some who already had post-graduate qualifications. None wanted to be professional astronomers (and the course was not designed to lead to that) but all were very keen. There were accountants, teachers, lawyers, musicians, IT professionals, housewives, divers, doctors, technicians and retirees. And they came from all over the world. I have little idea what happened to any of them after I finished but it sure was fun at the time conversing with them.

One of the more famous of Swinburne's students (after my time) was Anousheh Ansari an Iranian-American engineer who went to the Space Station in 2006.

The only downside was that we never got to meet fellow students or tutors. The Astrofest I attended this year was an attempt to remedy that for current students. There were about thirty of us for this one (there had been one previous meeting in Texas which I missed) and we were treated to a variety of lectures and hands-on observational (a remote telescope in the Netherlands) and computational astronomy using Swinburne's supercomputer.

I presented a short paper based on the two posters which we had prepared for the Mt John meeting earlier in the year and was delighted when a number of the present students approached me afterwards expressing interest in doing variable star work either as a visual observer or else as a CCD or DSLR observer.

After the formal lectures we had a day trip to the Keck observatory. I'd been on the top of Mauna Kea once before but had only seen the outside of the telescopes. This time we had a private tour of the Keck given by a couple of the resident technicians. I thought I was prepared for the size of each of the twin scopes but I was still surprised when standing beside one. It was cloudy and likely to rain so they didn't open the dome but they did turn the scope through 90° so we got a good look at the mirrors and the laser guide system.

The two cyclones that threatened to derail the weekend never got close to the island but they did produce a lot of cloud so the evening observing sessions never eventuated.

If any of our members are thinking of doing any further study I'd thoroughly recommend any of the three Swinburne programmes: Graduate Certificate of Science (Astronomy); Graduate Diploma of Science (Astronomy) and Master of Science (Astronomy). Look them up at <https://astronomy.swin.edu.au/sao/>

Publication watch

David Moriarty had a paper published in the JAAVSO on TW Crucis.

Moriarty D J W, *Period Analysis, Photometry, and Astrophysical Models of the Eclipsing Binary TW Crucis*, JAAVSO, Vol 43 2015.

Abstract. TW Crucis is a W-type W UMa contact eclipsing binary that has not been studied in detail since discovery in 1926. During 5 seasons from 2011 to 2015, photometric CCD observations were obtained mostly in the V passband, but also some light curves in B and I passbands. The period was found to be 0.3881444 ± 0.0000006 days, which is not substantially different from the original period of 0.3881358 days. There were slight variations in the period from cycle to cycle and year to year, which are most likely due to asymmetry in the light curves caused by star spots. A preliminary model of the light curves indicates the mass ratio may be about 0.67, inclination 70.8° and fillout factor 0.11. As no spectra are available, the range in B-V and V-I colour indices of 0.82 – 0.87 and 0.87 – 0.92 respectively were used to estimate the effective temperatures for the modelling, based on the spectral types of K0 – K2. The spectral type may be earlier, if the colour indices are affected by interstellar reddening. Star spots, which changed over short period cycles and were required to obtain good fits of the models to the light curves, indicate the stars are magnetically active.

Software watch

Prism, the telescope and CCD control software favoured by Europeans over its main rival MaxImCCD has just released a major new version. V10.1 of Prism Pro is available for 45 day free trial from <http://prism-america.com/>. The program comes in three flavours - Basic, Pro and Advanced.

From the website “[the] program has a fully integrated planetarium Sky Chart which allows you to plan your observations using a wide range of both star and deep sky object catalogs. Capturing CCD and DSLR images is easy with support for most CCD cameras and Canon DSLRs. Built-in tools like Autofocus and Autocenter make your job even easier.

Prism has a fully automatic observation function that does everything for you; from opening the dome or roof, cooling the camera, auto focusing, auto centering the target, and capturing images. It will then warm up the camera, park the telescope and close the roof or dome. It will even monitor your weather station or cloud sensor to make sure you get as many observations as possible from your imaging system.

After taking the images, use Prism to calibrate, stack and fully process your images. Sophisticated

image tools allow easy identification of your best images. Photometry and asteroid/comet search tools are also included.

Polar alignment using the King Method is simple and our pointing model capability will ensure your mount is always on target.

Prism also has a powerful and easy to use script language to allow you to write your own scripts. These scripts can then be integrated right into the Prism menu system.”

Full documentation is available in English and there are three video tutorials to help you get started.

Hardware watch

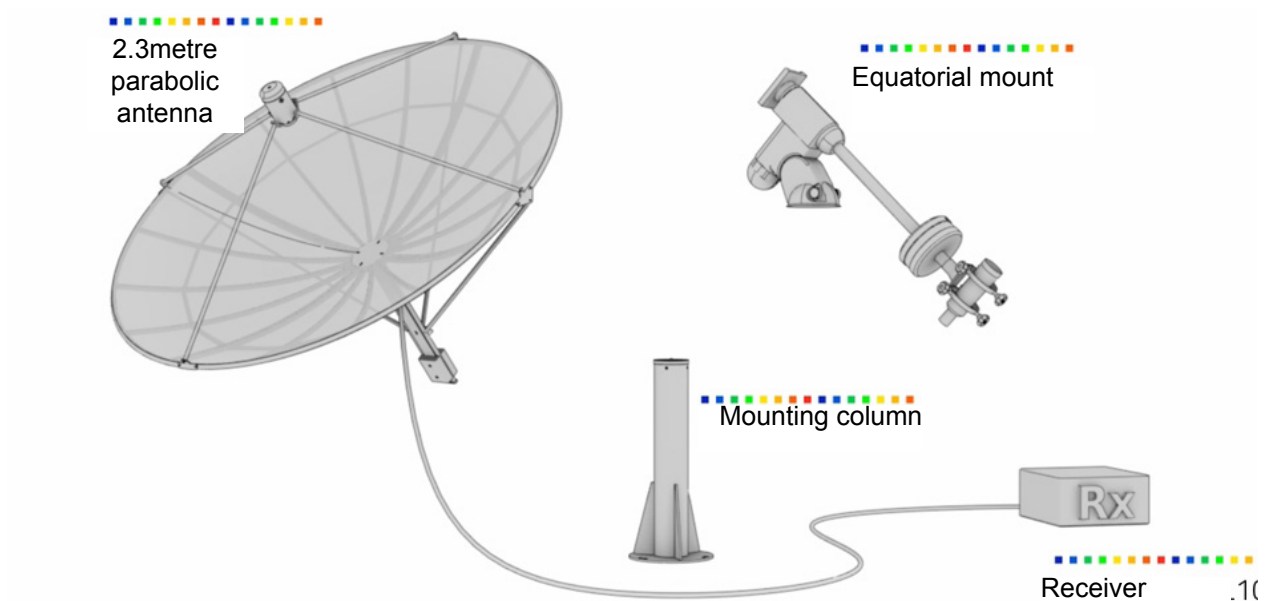
If, like me, you are getting fed up with the cloudy nights then you may want to consider a change of focus - to radio astronomy!

Italian company PrimaLuce Lab (<http://www.primalucelab.com/>) has introduced the Spider 230 radio telescope suitable for (and priced for) amateurs.

From the website the kit consists:

“A complete and functional instrument:

- - WEB230 parabolic dish with support device for equatorial mounts
- - N-EQ6 SkyScan equatorial mount with Synscan and 2 counterweights
- - Alignment optical finder system on mount counterweight shaft
- - 50mm finder, 8 magnifications, with glass solar filter
- - Column for installation on a concrete base and EQ6 flange connection
- - RAL10PL receiver thermal stabilized and with waterproof box
- - Ku-band feed-horn
- - High gain and stability Ku-band 4106C LNB
- - RadioUniverse control and RUviz processing software
- - User and installation manual (English and Italian)”



About

Variable Stars South is an international association of astronomers, mainly amateur, interested in researching the rich and under-explored myriad of southern variable stars.

Renamed from the Variable Star Section of the Royal Astronomical Society of New Zealand, it was founded in 1927 by the late Dr Frank Bateson, OBE, and became the recognised centre for Southern Hemisphere variable star research.

VSS covers many areas and techniques of variable star research, organised into “Projects” such as Beginners’ Visual Observations and Dual-Maxima Miras. The goal of each project is to obtain scientifically useful data and results. These may be published in recognised journals, or supplied to international specialist data collection organisations.

VSS is entirely an internet based organisation, working through our website <http://www.VariableStars-South.org> and its e-group <http://groups.google.com/group/vss-members>. It also encourages members to work in with major international organisations such as the British Astronomical Association, the Center for Backyard Astrophysics and the American Association for Variable Star Observers.

To find out more, please visit our website, where, incidentally, you will find PDF copies of all our newsletters. Our website has a great deal of information for VSS members, and for anyone interested in southern hemisphere variable star research. All VSS project information and data is kept here too.

Who’s who

Director Stan Walker, FRAS.

Treasurer/Membership Bob Evans

Newsletter Editor Phil Evans

Webmaster David O’Driscoll

Visit our website to see a list of our area advisers, and to find out about our projects and how to contact their leaders

Membership

New members are welcome. There is no annual subscription but donations would be gratefully received. Find out how to join by visiting the VSS website. There you will find out how to join by post, email, or directly online. If you join by email or online and wish to make a donation you will get a link to pay by PayPal’s secure online payment system, from your credit card or bank account.

After you’ve joined and received your membership certificate, you will be signed up to the VSS-members egroup (see above), and you will also receive a password to access the members’ areas of our website.

Newsletter items

These are welcomed and should be sent to the Editor (phil@astrofizz.com). I’d prefer Microsoft Word (or compatible) files with graphics sent separately. Don’t use elaborate formatting or fancy fonts and please do not send your contribution as a fully formatted PDF file.

Publication dates are January, April, July and October, nominally on the twentieth day of these months and the copy deadline is the thirteenth of the month though earlier would always be appreciated.

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