



Newsletter 2009/4

2009 November

FROM THE DIRECTOR & EDITOR

Tom's been rather busy this month on a variety of projects to do with his new observatory and property so nothing from him this issue—except for the long and detailed report on eclipsing binaries beginning on page 4. That project seems to be going well and producing results. The Bright Cepheid project is also producing data, although the analysis methods are such that it cannot be analysed in detail until the project has been operating longer.

We'd like a little more variety in items for the Newsletter and some more topical small items. The weather in NZ hasn't been exciting this winter and spring and maybe this is fairly general but some of you must be doing some observing. I saw an interesting light curve of the Eridanus nova by Terry Bohlson with some magnitude variation—rather unusual for a nova where at the 14 day mark we're usually seeing only the expanding shell, but this can have rifts in it where we see into the hotter regions below.

The EEB project seems to be going well although Tom's recent targets are largely CCD. So with the western part of the Milky Way coming into view as summer comes on maybe some of the visual observers could give the Bright Cepheid project a whirl—full charts will be on the website before the New Year.

And on this topic—season's greetings to everyone.

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STARS OF THE QUARTER

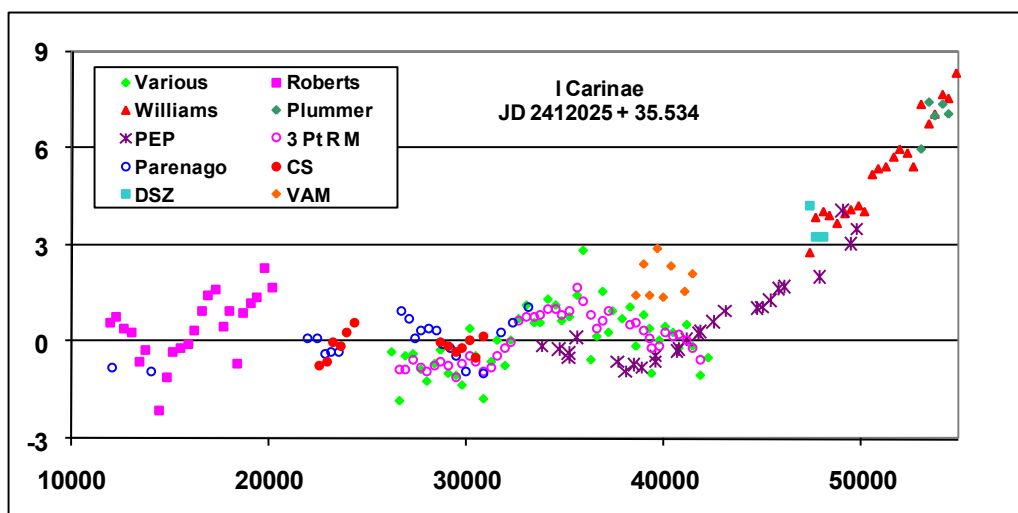
Stan Walker

I Carinae

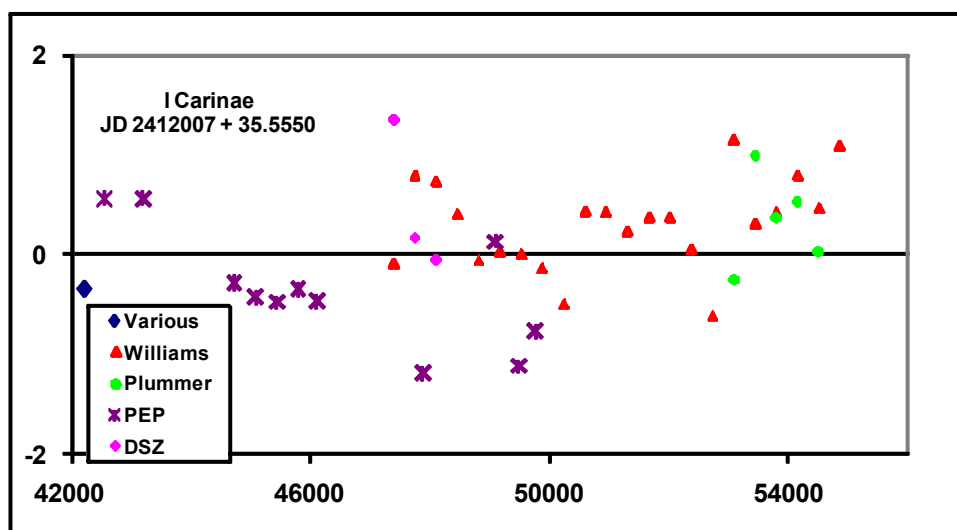
This seems to be a good year for novae and unusual CVs but lets begin with a more modest object—even though it's a few thousand times more luminous than the Sun. Almost every visual observer has looked at this star at some time—but after the initial enthusiasm it ends in the discards. So I was very impressed with Peter Williams' dedication to this star (and even more so U Carinae where he seems to be the most prolific observer of all time!).

Parenago shows an epoch of maximum in 1836 and another in 1871 but Roberts in South Africa seems to have been the first consistent observer, beginning in 1891. Use has been made of observations from the International Database of the AAVSO to determine epochs of maximum and plot an O-C diagram. These diagrams are ideal for studying historical period changes in a pulsating star. Period search software will provide an apparently good period but the small baseline leads to essentially crude values, whereas fitting slopes to the trends in the O-C plot is rather more accurate.

In this case there is a reasonable indication that before the major period change about 1968 *I Carinae* was unstable with episodes of the longer period present before the final change.



How good are epochs derived from visual measures? Observations since 1974 are plotted next with the current period. Almost all visual epochs lie within one day of the predicted values and more than half within 12 hours. If the PEP measures are removed—and these

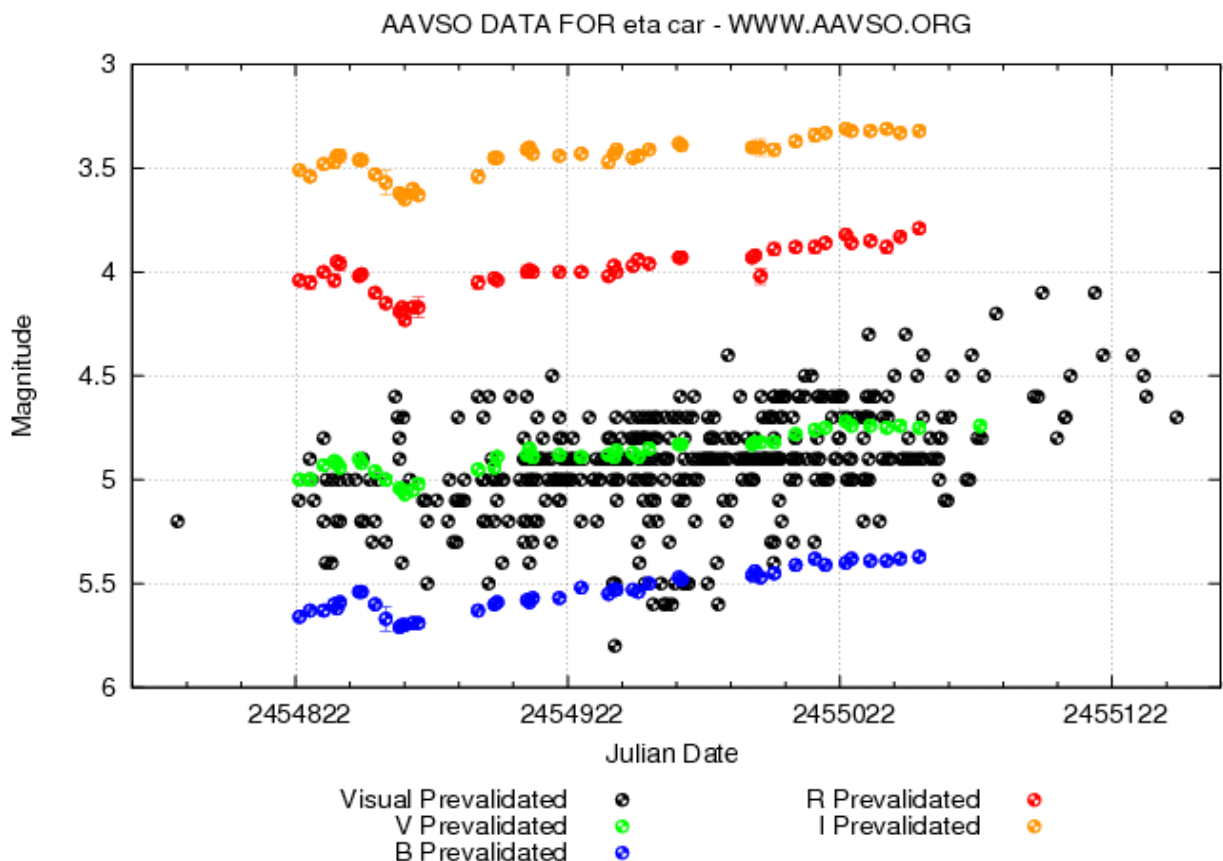


probably have a slight time offset—the accuracy is even better. These fits are based on less than 100 measures in every case. So join our Bright Cepheid project—described in more detail on page 29—if you like binocular observing.

eta Carinae

K. Davidson and A. Mehner, University of Minnesota; and J. C. Martin, University of Illinois at Springfield, on behalf of a group using the Hubble Space Telescope, report that the central star in eta Car has recently brightened to $V = 5.1$. This includes a region only $0''.3$ across, in spectra obtained with the Space Telescope Imaging Spectrograph (STIS) on 2009 Aug. 19. The star now accounts for half of the total light seen in the Homunculus nebula, compared to less than 10 percent before 1995. In view of the central star's 0.6-magnitude brightening since its 2006 peak (Martin et al. 2006, A.J. 132, 2717), unsteadiness in 2007-2008, and 0.5-magnitude increase in mid-2009, eta Car currently merits frequent attention by additional observers. See also <http://etacar.fcaglp.unlp.edu.ar/>.

This star was reviewed by Bill Allen at the 2009 Colloquium—see pp 33-34—and is obviously quite active at present.



We've extracted a graph from the AAVSO data plotter showing measures during 2009 which seem to confirm a slow but definite rise. It's quite bright at near IR wavelengths—as you would expect from all the dust around it—but there's no indication of colour or temperature changes. The one magnitude spread of visual measures is a problem but in general these show a brightening over the year. This, however, must be taken in context with the known changes in this star which is still recovering from the last periastron passage. But make it first on your list every night!

And as I conclude this Newsletter, notice of a very interesting nova in Eridanus—see the reviews on the AAVSO website (<http://www.aavso.org>) for more details.

EQUATORIAL ECLIPSING BINARIES REPORT – OCTOBER, 2009

Tom Richards, Project Leader

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The EEB Project is joint with the British Astronomical Association's Variable Star Section, with the aim of improving data on a number of eclipsing binaries that are observable from both hemispheres. The collaboration has been valuable in giving data from a wider range of longitudes than usual.

Stars in the observing list so far are:

Star	Number of Observers
Delta Librae	8 (6 visual, 1 DSLR, 1 both)
V1243 Aquilae	3 (all CCD)
V1646 Aquilae	2 (both CCD)
V1490 and V 1646 Aql	unobserved
UV Piscium	3 (all CCD)
SZ Piscium	unobserved
WZ Ceti	1 (CCD)

This report will cover Delta Lib and the two observed Aql stars. There is also good data coming in on UV Psc, particularly from David Boyd in the UK, but it's a little early to report on that. I've written this interim report to emphasize problems and issues in the data and its analysis, rather than to present definite conclusions.

Delta Librae

Delta Lib is listed in the GCVS4 catalogue (Kholopov *et al*, 2004) as an EA/SD pair (Algol-like light curve, stars are semi-detached – that is, one fills its Roche Lobe and so is presumably transferring material to the other.) The GCVS4 light elements are 2442960.6994 + 2.3273543 E. (Read this as Period of 2.323... days, and an Epoch (measured time of primary minimum) HJD 244....) Note how long ago that epoch is – 1976 July 1!

At magnitude 4.91 V, and a one-magnitude amplitude, the star is within the range of visual observers, and indeed most observation sets received are visual using binoculars or a small telescope. Visual observers usually report on much longer-period variables with much greater amplitudes, making one observation in a night. But an eclipser like this requires many observations at short time intervals, so it makes an interesting experiment to see whether visual observing can be used well on this type of star. One observer, Steve Kerr (Australia) submitted both visual and DSLR observations and his DSLR data fitted well with the visual data. Des Loughney (UK) submitted just DSLR data, obtained over several nights in the Canary Islands. His consolidated phase plot is in Figure 1. It captures an entire secondary minimum but just misses a primary minimum. The precision of the data is evident. Remarks by Des are appended to this report.

Of the visual data, Aline Homes (NZ) provided data on 43 nights from May 27th onwards – a great effort! Margaret Streamer (Australia) covered 17 nights, Peter Williams (AU) 12, Alan Plummer (AU) 11, Bob Evans (NZ) 5, and Steve Kerr (AU) two.

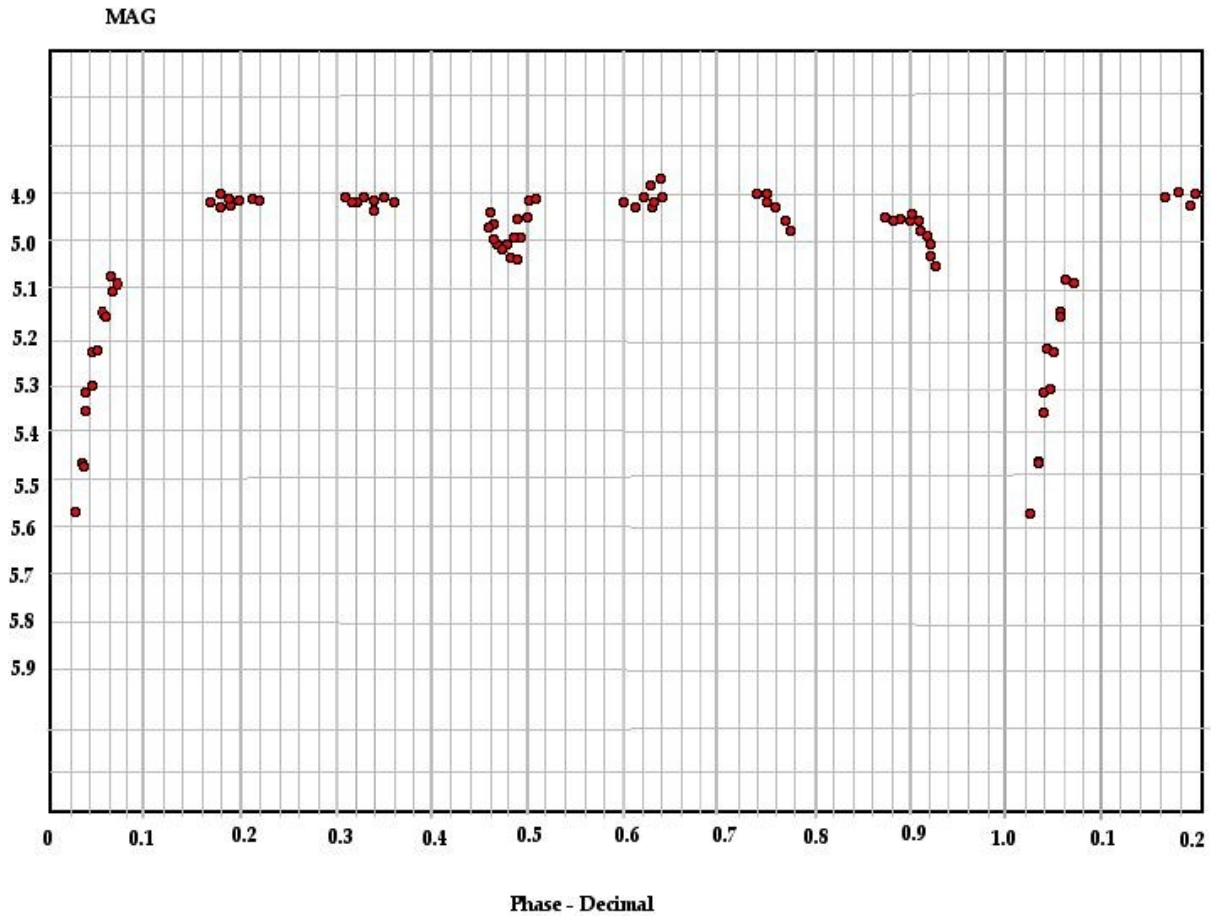


Figure 1. Delta Lib phase plot from DSLR data by Des Loughney.

In analyzing the data for this star, I've been immeasurably helped by Ranald McIntosh, who prepared all the data for the period analysis program PERANSO (see ref); and wrote a program to split an observer's table of observations into one-night groups (or other intervals) which simplifies handling in PERANSO.

Taking Ranald's PERANSO file and running various period-finding algorithms on it yields slightly different periods, but all are very close to the catalogue one of 2.3273543 days. Figure 2 shows a phase plot folded on a period of 2.3293 d, obtained using ANOVA. The error is large however, 0.0201 d; and some refining of the data (and extension into the next apparition) is needed before a usefully accurate period and epoch can be determined. It's even difficult to get good individual times of minimum from the data. One estimate I've made indicates observed minima are running 0.026 d early, but that is hardly outside the limits of error.

In Figure 2, Des's secondary minimum is clearly visible (bright green). The uneclipsed portions show that there's a variation of 0.1 mag in estimates overall. The "filled" appearance of the primary eclipse is due to vertical (mag estimate) errors, rather than horizontal (timing) errors; but it does seem the error is larger in eclipse than out of it. Analysis of individual observation sets will help to understand what's going on here. The obvious question raised is "are visual observations good enough for eclipsing binary work?"; but a better question might be "how can the data from individual observers be improved to give better results?" For example, where an observer provides just one or two observa-

tions in a night, it is much harder to see how good they are than if the observer provided a dozen or so encompassing a minimum.

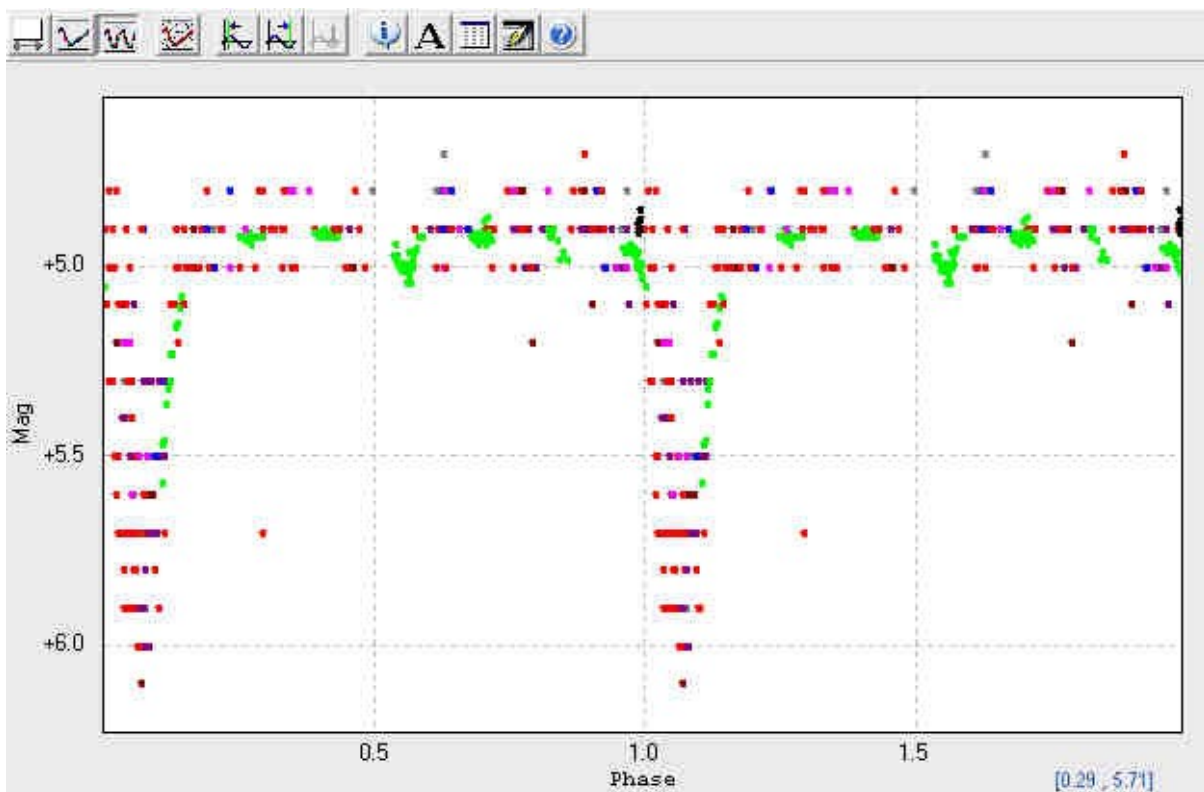


Figure 2. PERANSO phase plot of all Delta Lib observations, folded on 2.3293 d

V1243 Aquilae

V1243 Aql is an EA eclipser (one with an Algol-like light curve), listed in GCVS 4 as mag. 13.3 (photographic) with an amplitude of 0.6 mag. The more up-to-date Krakow catalogue (Kreiner, 2004) gives as light elements $2452500.762(7) + 0.7030492(5)E$. The ASAS3 catalogue (Pojmanski, 2002) lists double that period, i.e. the primary and secondary minima had been conflated in the 0.7 d period. However the ASAS3 data is poor since the star is too faint for its instrumentation.

The campaign on this star started in August. Since then until the end of the apparition in early October we have collected 16 time-series observation sets on 16 different nights: one by myself, one by David O'Driscoll (Australia) and the rest by Phil Evans (Cook Is.) – a total of 932 data points. Yet in all that only five minima were observed and some of those not well. However that sufficed in PERANSO to get a superficially good light curve phased at 0.703(1) d (Figure 3). But a closer look shows problems.

First of all, the minima that are folded together are obviously of different depth. Is this because of the use of different equipment, or are we conflating the primary and secondary minima here? Different equipment as the culprit is possible. Look at the black observation set (mine). It covers only part of the dive to minimum and even less of the climb out. If it included the shoulders (the flat parts before and after the eclipse) it would be possible to slide those data points up or down to match the shoulder height of the other data. More definitely, there is a silver bunch of data points on the ingress shoulder that

are clearly 0.05 mag out of line with the rest of the shoulder data. That is David's observation set, but at least with that one we can measure how much it needs tweaking upwards. With my black eclipse observation set, we cannot. This illustrates the utility of obtaining transformed data, i.e. data from which instrumental biases in colour and intensity have been removed, so that it conforms with standardised intensities and colour sensitivities. However, for period finding, that is not so important.

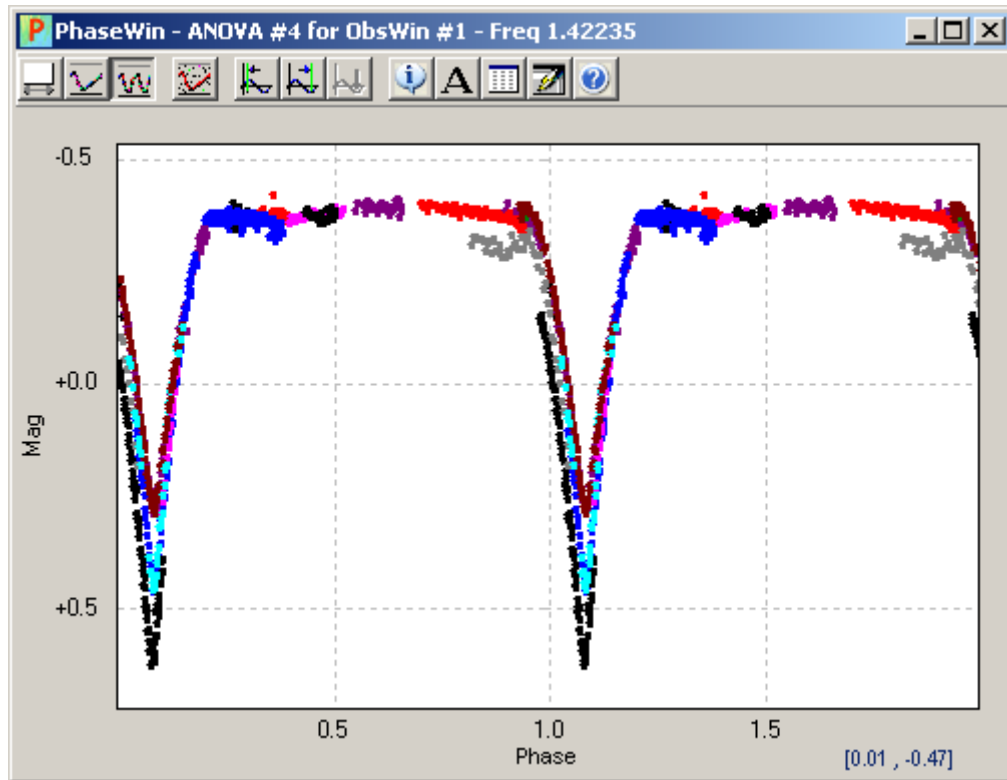


Figure 3. PERANSO data for V1243 Aql phased on 0.703 d. Note this diagram shows a double-phase view (repeats the data once).

Another suspicious feature of this phase plot is that there is no secondary minimum at all. Figure 3 shows the primary minimum twice, of course, but there is no hint of a dip halfway between. So could it be that the catalogue data has it wrong – that we have folded the secondary minimum onto the primary one? Figure 4 shows a phase plot at twice that period – 1.407 d. This is more promising, but still leaves room for doubt about whether this is actually the right period. The trouble is that there are only three observation sets for the “primary” minimum, near the centre. The black set (mine, with R filter) we have noted has no shoulder to give a vertical zero-point, and anyway it looks as if it's shifted downwards compared to the other two (Phil Evans, unfiltered). The dark blue curve is very good and conclusively shows an eclipse depth of 0.82 mag. The light blue curve does not have a shoulder, but it's still Phil's and has the same minimum as his other curve. So strictly, we're relying on just one observation set for the “primary” minimum – Phil's dark blue one.

The “secondary” minimum fares better – there are two observation sets for it – again Phil's – that include shoulders, and both agree on an eclipse depth of 0.62 mag. I think this makes the case for a period of 1.407 d very likely, rather than half that. ASAS3 data

folds well on a 1.406 d period.

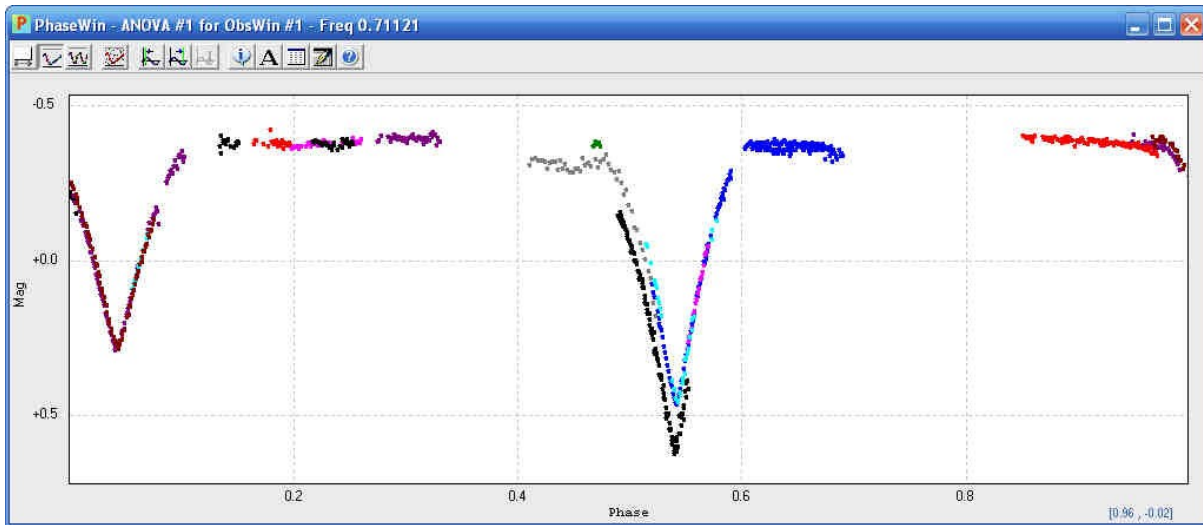


Figure 4: The same data phased on 1.406 d. This shows a single-phase view with "primary" eclipse near the middle and "secondary" on the left.

If so, we're looking at two stars that partially eclipse each other (since the minima are curved not flat). But this plot shows a problem – the eclipses seem too deep, as Stan Walker pointed out to me. Let's see. The one well-observed "primary" eclipse (Phil's) is about 0.82 mag, a drop to ~47% of the uneclipsed brightness. So the eclipsing star (the secondary star) has ~47% of the flux of the combined stars, or less if the eclipse is partial. But now, the two well-observed secondary eclipses (Phil's) both drop ~0.62 mag or to ~56% of total flux. Even if this eclipse totally occulted the secondary, the drop should be at most 47%. Since the curve suggests it partially covers the secondary, it will be less. (If you think about it, the sum total of flux drop in the two eclipses of a binary can never exceed 100%, and it can only reach that figure in the unlikely case of each eclipse being total – two stars of the same size in an orbit that lies exactly in our line of sight. Here the total drop is ~97% .)

We seem now to have two inconsistent results: (a) two quite different well-measured depths of eclipse pointing to a 1.407 d period as in Figure 4, and (b) the same two measured depths being almost too great to be astrophysically possible. How do we resolve this?

We need more observations of eclipses that include the shoulders so we can get accurate depths. We need to check if there's any sign of a shallow secondary eclipse in the 0.7 d period. And we need to do all this with filters and preferably transformation of raw filtered data to the standard system, in case the eclipse depths we're seeing are due to observing with different filters and instrumentation. (However all three well-observed eclipses come from Phil Evans, unfiltered, and same instrumentation.) That will have to wait until the binary's next apparition, beginning around next February, which will also give us a much longer baseline for period calculation. We could also then look at some colour data (transformed of course) to see what we can infer about the colours and hence temperatures of the two stars. Maybe not much, since there is no total eclipse; but we'll

see.

V1692 Aql

This is classified in GCVS4 as EW (W Ursae Majoris type, a contact binary), with magnitude range 11.22-11.45 (unfiltered CCD), and period of 0.60926(6) days with epoch of HJD 2452140.960(2). How do these light elements square with our observations?

Neil Butterworth (Australia) provided four nights' data in August, and Yenal Ogmen (North Cyprus) provided a set in October. Neil captured two minima of unequal depth and one maximum, and Yenal a minimum. Unfortunately none of these observation sets contain a maximum and a minimum, so we don't really know the amplitudes of the minima. But we can assume that the difference between Neil's two minima (0.05 mag) is because one is a primary and one is a secondary minimum. This is confirmed by the interval between them, 2.1359 d, which is near enough to seven times the catalogue half-period (0.305 d).

The observed times of minimum are running about 50.4 minutes late compared to the GCVS predictions, i.e. (O-C) = 0.035 d. This lies well outside the accumulated uncertainty in the GCVS period over the time since that epoch; so it would appear the period is increasing. More work is needed however to get a good grip on this change, including a search for other published times of minimum. Wait till the next apparition.

References

Kholopov, P.N. *et al*, 2004. *General Catalogue of Variable Stars*, 4th ed., Moscow.; <http://www.sai.msu.su/gcvs/>

Kreiner, J.M., 2004, *Acta Astronomica* **54**, 207-210; <http://www.as.up.krakow.pl/en-ascii/index.php>

Pojmanski, G. 2002, *Acta Astronomica*, **52**,397; <http://www.astrouw.edu.pl/>

A DSLR EXPERIMENT

Des Loughney

Delta Librae is a good target for DSLR photometry. Being bright it will be easy to find and centre in the viewfinder of a DSLR. There is an opportunity to do both unfiltered photometry and V photometry to a precision of plus or minus 0.02 magnitude.

It is not necessary to do V photometry on eclipsing binaries to get good and valuable scientific results. This is because the shape of the light curve is exactly the same whether the estimates are unfiltered or not. Unfiltered photometry allows good estimations of the time of mid eclipse.

A first stage in the campaign will be the working out of the right settings for your particular camera. With a Canon 450D DSLR the settings will probably be, with a 85 mm

lens, an exposure of 5 seconds, ISO 400 and f 3.2. Settings will vary with lens aperture. It is possible that settings may have to be varied to take account of the height of the system above the horizon. Another setting adjustment may be necessary to capture the right amount of light at primary minimum. All this will be determined empirically by members of the Campaign. With the sharing of experience very good results can be obtained fairly quickly using the DSLR photometry technique.

The RAW images of your camera will need to be analysed in sets of ten using a software package such as AIP4WIN. A set of ten can be stacked (and dark frames subtracted) and the average image analysed with the photometric tools. High precision can be obtained by doing 30 images in one go and then subdividing them into three sets of ten for analysis. This allows an estimation of standard deviation and standard error.

With the right settings and with care the target precision of plus or minus 0.02 magnitude can be achieved. This can be very satisfying as it will allow a very precise timing of mid eclipse and it will pick up subtle features of the delta librae light curve due to starspots and hot spots.

The aim of the first part of the campaign will be for all participants to be achieving similar results and similar precision. Once this common standard has been achieved it will produce very good results particularly when more than one observer is able to study the same eclipse.

A second stage can be doing V photometry. Guidance can be given on the technique which has worked well for the International Epsilon Aurigae Campaign. The most challenging part is working out the transformation co-efficient (TC) of your camera. This requires a study of a group of unvarying stars taking into account their colour (B-V).

We know that the TC for the Canon 450D is 0.15. For other makes and models it may be different. We have guidance notes on how to do determine the TC though our groups of stars are all in the Northern Hemisphere.

Once you know the TC you analyse, using AIP4WIN's photometry tools, the green channel image of a RAW image. The V magnitude can then be estimated. If you have (as you should have) archived your image sets then V photometry can be done at a later stage.

We have developed a worksheet for recording DSLR observations and another for converting the AIP4WIN result into a magnitude. These may be useful for members of the Campaign.

DSLR EXPERIENCES

I see that one or two members are actually getting results with these. I'd very much like to hear how it's all working out. Not necessarily as a NL article but the exchange of experiences would be useful to those trying to get started. So can those of you who are getting good results drop me a note? Stan.Walker@varstars.org

REPORT FROM THE VISUAL OBSERVING DESK

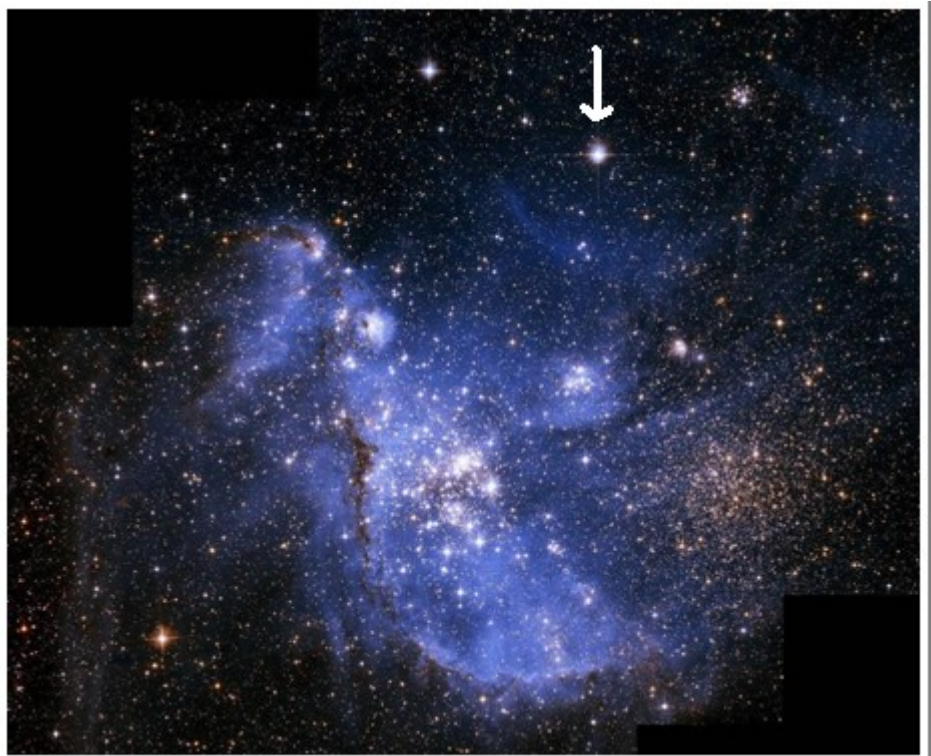
Alan Plummer

The VSS Beginner's Project is roughly half way through its observing time, with R and eta Car morning objects now, but still observed (thanks to the people who get up from their warm beds...) Both the Dual Max and the Eclipsing Binary projects have involved visual observers, and will be detailed elsewhere. So, what next do visual observers do best? Enjoy the sights along the way. Here are some special ones:

HD 5980 and NGC 346

Well placed for this time of year is the 11th magnitude HD 5980 pictured in Figure 1; the most luminous system in the Small Magellanic Cloud. This star is well worth observing in its own right, quite apart from its strikingly beautiful location.

If you look at the SMC in binoculars or a finder scope, the open cluster NGC 346 and its associated HII region designated N66 make the brightest fuzzy patch you can see. HD 5980 is a member of this cluster, which is up there with the most massive clusters known. A 20cm telescope is probably the minimum aperture to reliably observe this star, and high magnification is called for too.

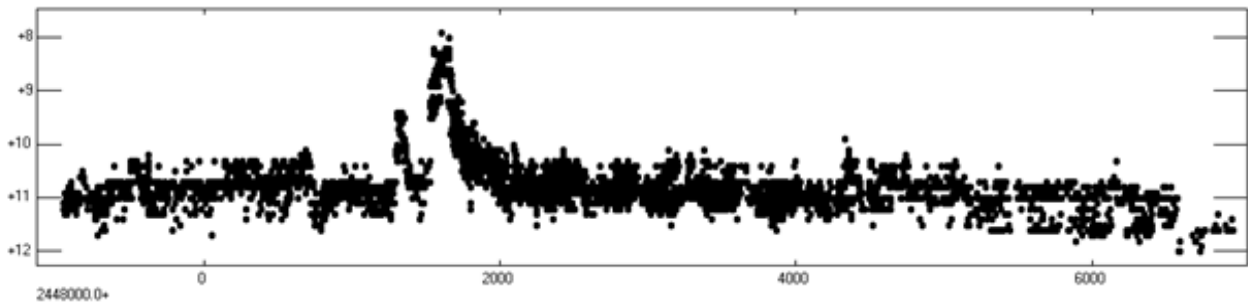


With a 40cm mirror the cluster itself is well resolved out of the nebulosity, with other clusters and nebulae densely packed in the eyepiece field.

HD 5980 is a triple system whose components have been described (Koenigsberger [2004RMxAA..40..107K](#)) as follows: Star A is Luminous Blue Variable of 50M $\odot$ (50 times the mass of the Sun) in a 19 day orbit with star B, which is 20M $\odot$ with a Wolf-Rayet spectrum. Despite how big these stars are thought to be today, it is estimated that their combined initial mass was 120M $\odot$ before blasting away vast amounts of gas with radiation pressure and a very fast rotation. Star C is little known, possibly a line of sight object rather than bound to the system, and of spectrum O4-6. If this system was the same distance from us as Alpha Centauri it would shine as brightly as the full moon.

Star A has been observed to erupt in the past. Figure 2 shows the light curve from the AAVSO international data base beginning in 1987. VSS life member Albert Jones discov-

ered the 1993-4 outburst, and looking into the recent data shows only Albert and myself regularly observing the star. Join in, please!



V639 Ara and NGC 6397

Figure 3 is an ESO picture of NGC 6397 and quite by chance the long period variable V639 Ara is at or near maximum. No prizes for spotting it – it's the red one at the top of the picture. Globular clusters like this are



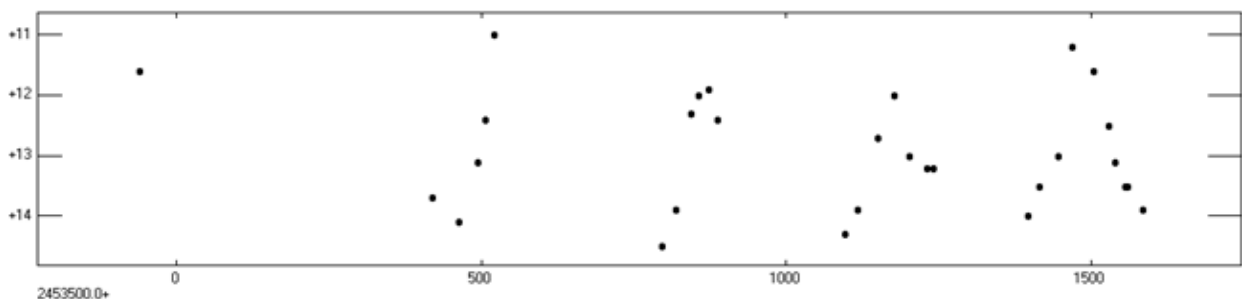
worth looking at in all apertures, but to be realistic a 25 cm mirror or larger should be used for observing the variable because of the cluttered field.

According to ESO Press Release 20/04 NGC 6397 is 7,200 light years away, making it the second nearest globular after M4, and contains about 400,000 stars. It's old; *very* old. Today's best estimates put it at ~13.4 billion years, with the Milky Way at ~13.6 and the universe itself coming in at ~13.7 billion.

The chart for V639 Ara is from a series made by VSS life member Mati Morel (numbered MM14), so you won't get it from

the AAVSO chart plotter. I urge anyone interested to contact Mati or myself about these; there are many wonderful under observed southern objects on offer.

This star is classified a Mira variable, spectrum Me, with a range of 11.2-16p and period of 314.6 days. If you observe this one, you'll be one of only two observers logging observations; the ASAS and myself. The ASAS can't follow it all the way down, and I hope to do better with a 40.6cm mirror. My observations are shown in Figure 4, with a 30cm telescope used up until the last three observations, where the 40cm takes over.



And more...

Figure 5 shows IL Nor and NGC 5927 in Lupus. Well, it *might* show the variable. IL Nor was Nova Normae 1893 and it's long gone into the distance. But then again, this very fine photograph by Daniel Verschate from Chile is a deep image, and the remnant could be visible in the drawn circle. In the eyepiece this cluster is joy to see; a rich Milky Way field



with the globular in the distance viewed close to the south side (underneath) of the galactic plane.

It is important to watch old novae in the event of them beginning dwarf nova eruptions – instances of this are discovered occasionally – or even showing another nova outburst.

And to finish, here are two more. First, Figure 6 shows V720 Oph near

M107; this is a Mira star and the chart to be used is MM11. And second, pictured in figure 7 is FI Hya near M68; another Mira, and needs chart MM6. So there's much to enjoy as we work through our chosen programs.



Captions and Credits

Figure 1. HD 5980 (arrowed) in NGC 346. Credit: [NASA](#), [ESA](#) and A. Nota ([STScI/ESA](#))

Figure 2. The lightcurve of HD 5980 beginning in 1987 from the AAVSO international data base.

Figure 3. NGC 6397 and V639 Ara Credit, ESO. V639 is the red star at the top

Figure 4. Observations of V639 Ara beginning March 2005

Figure 5. IL Nor and NGC 5927. Photo Daniel Verschate, Antilhue Observatory <http://www.verschate.cl/>

Figure 6. V720 Oph near M107. Photo DSS

Figure 7. FI Hya near M68. Photo DSS

MEETINGS HERE & THERE

NACAA XXIV will be held in Canberra over Easter, 2010, from 2-5 April, 2010. The theme is 'Astronomy in the On-line Age' and submissions were to be received by 28 November, 2009. Rather an early close off date—even most IAU Meetings don't use this length of lead in time! For details see the website (<http://www.nacaa.org.au>). This will be an excellent opportunity to meet with fellow VS observers and several meetings of Variable Stars South will take place over this period.

RASNZ Annual Conference will take place in Dunedin from 28-30 May, 2010, at the Otago Museum. Submissions for papers on any topics are requested—see the website at (<http://www.rasnz.org.nz>).

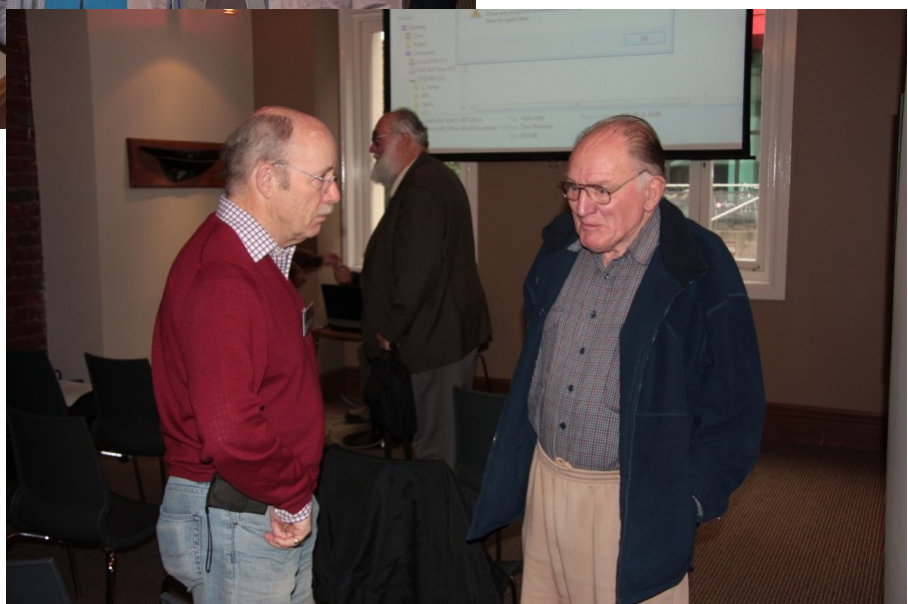


And since there's a bit of space to fill, a couple more pictures from the Colloquium showing a dramatic contrast—Ranald McIntosh, Pam Kilmartin and Alan Gilmore look very cheerful at left—but Bernard Heathcote and Stan Walker are very serious and pensive below. Maybe it was just the temperatures as the three South Islanders above are used to the sort of

weather we were having in Wellington that day, whereas Bernard and I come from rather warmer climes.

In the background of the second photo is Frank Andrews, formerly of Carter Observatory.

Carl Knight's second part of the Colloquium review appears on pages 30-37.



PUKEMARU OBSERVATORY

By Stephen Hovell

I really enjoyed reading Diana Watson's article in the last VSS Newsletter 2009/3. Diana, it was wonderful to see blue sky in your photo. I have forgotten what it looks like (the weather has been really bad here). I know our primary task is to observe but it is really important to put a face to a name, and I hope we can see more members of this section sharing about themselves, their instruments, and their passions for observing.

I first became interested in astronomy when Lionel Warner was our Science teacher at Lynfield College back in the early 1960s. He started up an Astronomy Club and that did much to motivate me. I joined the Auckland Astronomical Society when it moved from Queen Street to One Tree Hill around 1967. Ron Welch started talking to me about variables, specifically VW Hyi. Lionel Warner gave me an old 6" reflector and I joined the Variable Star Section of the RASNZ. Grant Christie started observing variables at the same time and we would often find ourselves at the Observatory or at Graham Loftus's, looking through his massive 20" and drinking cherry brandy to warm us up. Stan Walker, Brian Marino and Barry Menzies featured strongly on the Variables scene in those early days, and who can forget the grazing occultation at Glorit.

I moved north to teach at Ahipara, at the foot of Ninety Mile Beach in 1971 and have remained in the Far North ever since. I have been observing variables on and off over the years. Interest waxed and waned, depending on family, work and other community commitments. At one stage I was teaching at Te Hapua School, which is further north than where Stan is living (Latitude 34° 31'). I did quite a lot of astronomy education with school children in the Far North, and a lot of them managed to see Halley's Comet back in 1986. I still take my telescope out to school camps. It is quite refreshing in this age of computer games and other flashy technologies that children are still intrigued to see Saturn, Jupiter with its moons, and a crescent Venus as well as other deep-sky items.

I now live about 6 km north of Pāmapurua, up a windy, dusty and peaceful country road. There are not too many lights around although the Triboard Mill in Kaitia throws up some light on the western horizon behind some hills. I suspect the Mangamuka Range to the south has something to do with the cloudy skies and dew-laden air that gets attracted to my telescope. But apart from the cows that sometimes rub themselves up against my observatory to scratch themselves, I can't complain.

I have built an observing shelter. It's 3.6 metres square with a 1.2m roof covering 1/3 of it. That's where I keep my charts and lights and radio and table for observing. The other 2/3 is open to the heavens. To get power up there, I bought 130 metres of heavy duty extension cords, threaded them through alkathene pipes, and buried them so the cows wouldn't stand on them and pull them apart.

I have a 12" Meade LX200 GPS mounted alt-az on a heavy duty tripod. It's got the standard Meade 8x50 finder. I found that I needed something in between so that I could see



fainter stars than appeared in the finder, yet a wider field than the 12" so I recently bought an 80mm short-tube

I checked about the gumboots—essential if your observatory is out in a cattle paddock. I wonder how many of these sleeping pads get used as dew shields for telescopes?

Orion refractor from Bintel. (You can now get these in NZ). I fitted Losmandy plates

above and below the telescope. The 80mm is mounted above and a counterweight below. I have just got three heating elements for these three telescopes in an effort to reduce dewing. They work when I remember to turn them on. Recently, some of you may have been following VX For in outburst. On about the only partially fine night in the past 3 weeks, I managed to find the field but could only see down to about 11th mag. My telescope had dewed up. I realised that I had forgotten to turn on the dew heater so couldn't make any observations. How frustrating.

From the two stars mentioned above, you might realise that I enjoy observing CVs. On a good night I can get down to maybe 15.3, but usually about 14.8. When the Moon is bright, I use the time to look at brighter Miras as well as the brighter CVs. I observe any CVs (and RCBs) that get brighter than about 14.0

On cloudy nights, I have been spending a lot of time updating my RASNZ charts using the AAVSO's VSP (<http://www.aavso.org/observing/charts/vsp/>). If you don't know this website, it is an excellent place where you can set parameters for your own charts. The maximum field size is about 15° which makes it fairly easy to find stars. I use 15° charts down to mag 9.5 which is ideal for my finder. Then I star-hop to the variable which I can find quite readily in my main telescope. I print charts at about 70"=1mm (mag 12), 22" (mag 14) and 11" (mag 16). If the field is crowded, I do a 6" chart which works well with my 15mm eyepiece (magnification about 200x). Those chart scales match the RASNZ charts very closely, although they offer a slightly wider field of view.

By the way, I can see stars in Cassiopeia from my place. There aren't too many observers in NZ that can say that.

Stephen Hovell Pukemaru Observatory Kaitia NEW ZEALAND E 173° 20' S 35° 05'

ECLIPSING BINARIES FOR FUN AND PROFIT—Part III - Equipment and Software

Bob Nelson, PhD

In this article, I shall lay out some issues and procedures that need consideration before one takes any data.

Telescope and Mount:

Briefly stated, there are many telescopes that will do a good job for photometric measurements, be they Newtonian, Schmidt-Cassegrain or refracting. In general, the more aperture the better, but anything from 20-50 cm is just fine. Whatever you chose, the telescope should be well baffled to cut out reflections from tube walls, etc.

Of greater importance is the mount. It needs to be steady, motor-driven in both axes, have an RA drive with reasonably low periodic error and be capable of autoguiding. 'Go to' capability is highly desirable, but not absolutely necessary; however, you need to be able to acquire your target quickly and easily. Good finder scopes are indispensable if you do not have Go to capability. A permanent setup (e.g., in a roll-off observatory) will be a blessing, because it saves you much time and possible frustration.

Detector:

A range of detectors is available: the human eye; the single channel photometer (using either a photomultiplier tube or solid-state detector; the astronomical CCD (charge-coupled device) camera; or the ordinary digital camera. I shall now discuss each.

1. **The human eye:** This is readily available, requires no electronics, and -- when dark adapted -- is fairly sensitive. However, its main drawback is that it gives no quantitative output. You simply compare the star in question with a sequence of comparison stars that have been calibrated (using one of the electronic devices described below) and estimate. Precision is generally limited to about 0.1 magnitude; however, you can do a little better with the brighter stars. Another problem is the colour response of the eye, and whether you are using the fovea (the sensitive spot one reads with, etc.), or other parts of the retina using averted vision. The fovea contains both cones and rods (the former are active in bright light; the latter during dim light); the remainder of the retina, mostly rods only. It turns out that the spectral response of the cones peaks at about 555 nm (yellow-green), and the rods, at about 507 nm (blue-green). Therefore, if the comparison star is different in spectral type (and hence colour) from the program star, you will get different magnitude estimates depending on whether one uses the fovea (with the cones active when a bright star is imaged there) or averted vision. (See http://www.telescope-optics.net/eye_spectral_response.htm for an informative explanation of eye-related responses.)

In spite of these problems, observers for the American Association of Variable Star Observers (AAVSO) and others have kept track of magnitude changes of Mira stars (and other pulsators) for over 100 years. There, the level of precision of the eye is appropriate since Miras exhibit magnitude extremes (henceforth called *amplitudes*) of typically 2.5-10

magnitudes, and involve periods of typically 200-600 days. However, when it comes to eclipsing binaries, the amplitude is often less than one magnitude, and sometimes much less than that. Therefore visual ToMs for eclipsing binaries are, in the opinion of this author, of limited value since they typically yield precisions between 0.01 and 0.002 days (at best).

2. The single channel photometer: The photoelectric photometer (with a 1P-21 photomultiplier tube) was the first sensitive detector used for stellar work. (Indeed, it established the UBVRI magnitude scale -- see Johnson & Morgan 1953.) More modern photometers use more sensitive photomultiplier tubes (excellent in the UV and blue end of the visible range) or solid-state detectors (good in the IR and red end of the visible range). The problem with the single channel photometer is that you need to alternate between comparison star(s), the sky, and the program star. It gets awfully tedious doing it by hand, and any variation in sky transparency (over the field of view, or over time) can ruin the data. Although various methods have been invented to deal with both problems (computer-controlled telescope movement between targets, rocking secondary mirror, and multi-channel detectors), there still remain problems to be dealt with. Another serious problem with this type of detector is that if the star should slip out of the aperture (pinhole), there is no indication in the data. There is only one datum (the total count), and there is no remedy after the fact. However, solid-state photometers are important in the mid-IR range, where normal CCD cameras cannot operate.



3. CCD camera: This is the best detector. There is a multitude of choices available today varying from a few hundred dollars to a few thousand. As always, you get what you pay for; however, the requirements for just doing ToMs are not very great. As a general rule, you should always select target stars well suited in magnitude to your detector and aperture. Therefore, if one has a lower-priced detector and smaller aperture telescope, you can always just work on the brighter stars. (Some recommendations will follow later.)

The virtues of CCD cameras are many. Chief among them is their ability to image a whole section of the sky at once. Therefore, any time-dependent variations in the sky transparency will be experienced by all the stars on the frame at once, and will therefore cancel out. The exception would when fine-structure clouds (the cirrus-type) are present; however, longer exposures will tend to average out changes as the clouds move.

Another advantage is that one has a complete record of a whole section of sky; over time, one can search for variability anywhere in the field, make a change in comparison stars, measure star positions, etc.

CCD cameras designed for astronomical purposes can almost always be *cooled* -- a highly desirable feature to beat back the dark current (signal with no light falling on the CCD chip). For these scientific purposes, they should always be obtained *without* an anti-blooming gate (ABG). (The latter is a set of channels designed to remove an overflow of electrons that results when a very bright star lies in the field and causes streaking in the image. An ABG is a desirable feature for astrophotography but is a real pain when doing measurements -- it *steals* electrons!)



CCD cameras must always be connected to a computer. However, this is not a problem these days as there are many inexpensive laptop or notebook computers that will do the job for a temporary setup, or desktop computers suitable for a permanent observatory. In any case, one will always want to process the images, a task impossible without a computer!

4. Digital camera: Consumer-grade digital cameras have been around since ~2000. They differ from most astronomical CCD cameras in that they must record in three colours (RGB) and have microlenses to do the job. Meaningful photometry, however, is problematic at best. The main problem is that most digital cameras save in 24-bit JPEG or TIFF format which is unsuitable for photometry. (Twenty-four bits means 8 bits each of the R, G, B colours. Eight bits means that, for a given colour, the count for each pixel is 0 to $2^8-1=255$. This is woefully inadequate for any kind of photometry.) The camera will need to save in a RAW format giving 12 bits or more, single channel. There are other problems. If you must attempt photometry with a digital camera, there is much information on the internet -- key in "photometry" and "digital camera" into your favourite search engine.



The following discussion will be limited to monochromatic astronomical CCD cameras.

The CCD Camera

A full discussion of the theory and operation of the CCD camera is not possible here; however, I will limit myself to a few remarks.

Most people know that the CCD chip consists of an array of $n \times m$ pixels (mine is an SBIG ST-7 XME with 765×510 pixels). Photons hit the chip and create electrons which are stored in various pixels. After an exposure, these electrons are read out, usually row by row and stored as counts in the computer's memory where they can be reassembled into a 2-dimensional image for display. Usually the image is stored as a Flexible Image Transport System (FITS) file whereby information about the image is stored as text in a header

and the pixel values stored as binary code in the image part of the file. (There are other file storage systems, but usually these may be converted to FITS files.)

Of importance is the sensitivity of the chip (expressed as the quantum efficiency -- QE) and its spectral response. Today's CCD cameras have peak QEs approaching 90% and can be had for around a couple of thousand dollars. (Expensive back-illuminated models even approach 100%!) If you are interested in doing serious photometry, it makes sense to buy a sensitive camera since that is equivalent to having a larger telescope!

The issue of spectral response is important, because you want a reasonable QE over as wide a range of wavelengths as possible for either photometry or astrophotography. Many cameras have a range from the near ultraviolet to the near infrared; however, the QE does fall off on either side of the peak, so the QE in the blue might be only half the value at the peak (usually near 600 nm, which is orange-red).

The issue of *pixel size* is important. For most sites, star angular sizes are limited by atmospheric *seeing* to between 2 and 5 arcseconds. The *plate scale* of your telescope may be found by dividing the focal length into 206265 (the number of arcseconds in a radian). Thus, for the author's telescope (having a focal length of 1500 mm), we get $206265 / 1500 = 137$ arcsec/mm. The pixel size of the ST-7 is 0.007 mm; therefore each pixel sees $137 \times 0.007 = 0.96'' \sim 1$ arcsecond. This is about right, because on the nights of best seeing, I will be oversampling by a factor of 2 -- just right by the Nyquist criterion. Most of the time I will be oversampling, but that will not be a bad thing. You certainly don't want to *under-sample*! In cases of gross oversampling (say by a factor of 6 or more), you can always bin by -- say -- 2×2 . (This means that the camera will lump together the counts from all the pixels in 2×2 subsets, giving you $1/4$ the effective total number of pixels.)

The other point is that you want as large a chip as you can afford (compatible with your telescope's field of view that gives reasonable images). Large chips record much more of the sky, but do so at the expense of larger file sizes!

CCD cameras should be purchased with an off-axis *guider chip*. The latter permits you to lock onto a star just out of the field, preventing drift. Drift is bad because the star images will fall on different parts of the chip and -- although one will do flat-fielding and all the other things -- one still loses accuracy. Also, the star may drift off the chip!

For ToM determination, filters are not necessary; however, if you want to obtain light curves, you will want to make filtered observations (and likely astrophotography). Most photometrists at this level use the broad-band BVRI filters defined by Johnson & Morgan (1953) and modified by Cousins (1976). Filters are also useful when determining ToMs: for bright stars, one can dim the light by using a filter for the less sensitive wavelengths (especially B!). Also, if you try to make a practice of using a filter when doing ToMs, you can always use the data for light curve determination later on. (However, for the very faint stars, when exposures would exceed -- say -- 5-10 minutes, you will want to work unfiltered.)

Initial Reductions

CCD images need to be *reduced*. The first step is usually to subtract the *dark frame*. The dark frame, as the name implies, is an exposure taken with no light striking the chip (the camera's shutter is closed). This records the *dark current* suffered by each pixel that is due to thermal noise, etc. Cooling your camera to -- say -30°C -- reduces the dark current drastically but does not eliminate it completely. (In detail, most pixels have very low dark current. It is the dark current from the few 'warm pixels' that is reduced by cooling.) The software in the camera or in your computer subtracts the pixel values in the dark image from the program image.

In SBIG cameras, you have the option of taking a dark frame immediately after the 'light' exposure. However, this is extremely wasteful of telescope time: half the time is spent with the shutter closed! The usual practice is to obtain a library of master dark frames (for different CCD temperatures) at some other time -- the daytime or cloudy nights, for example. For master dark frames, you first need to obtain a master *bias frame*.

Bias frames are taken with the shutter closed and an exposure of 0 seconds. Bias values -- for a given pixel -- consist of three components: an offset, a systematic part, and a random part. The offset (sometimes called the pedestal) is a constant amount that is added by the camera to the value of each chip in order that the value is never negative. The systematic part represents some sort of pattern across the chip that is always there. The random part, as the name implies, varies from time to time by a small amount centred around zero.

If one takes a series of bias frames (typically 20-30), one can construct a *master bias* frame that is needed for processing later on. One uses the software to *median combine* -- that is, it takes the median (middle) value of the 30 values for each pixel. (The median value is safer than the mean, some of whose component terms may be extreme values that distort the mean.)

For example, for my CCD camera, a bias frame exhibits a mean value of 111 counts (this is the offset), individual pixel values in the master bias frame range from 102 to 207 with a standard deviation of 3.9 (this is the systematic part), and a given pixel in the each of the 30 images has values from 93 to 122 with a standard deviation of 6.9 (this is the random part).

All dark images (and indeed every other image that the camera takes) will have a bias component (pixel values with zero exposure) and values that are proportional to time. If the master bias frame is subtracted from each dark frame, one has values that can be *scaled* to different exposures. Therefore, for each of a series of temperatures (say -30° , -25° , -20° , -15°C), you take a series of 20-30 exposures (usually lasting for 1-2 minutes or more) and construct a master dark frame. (You subtract the master bias from each, then median-combine the resultant frames.) Different temperatures are needed because -- depending on the outside temperature -- one cannot always cool to the optimum -30°C .

In processing, the software will read off the exposure times for the master dark frame and the frame in question from the header (key word; EXPTIME or ITIME) and make the ap-

appropriate scaling.

Next, one needs to obtain *flat-field frames*. These are needed to deal with the fact that different pixels of the CCD chip will give you different responses when your telescope is pointed at an evenly-illuminated source (like the dusk or dawn sky, or a light box). This deviation from a constant response (across the chip) can come about from each of three causes.

1. Vignetting of the image. This is a drop-off in illumination towards the edges of the field (region of the focal plane that falls on the chip) that can occur in optical systems. It is caused by stops somewhere in the optical train. (Stops are needed to prevent internal reflections from tube walls, etc.) An undersized secondary also represents a stop. Vignetting can also be caused by a telecompressor lens in the system somewhere.

2. Systematic differences in sensitivity from pixel to pixel.

3. Dust particles. These can exist on any of the optical surfaces -- including the primary and secondary mirrors, either side of a filter, and either side of the thin glass that some manufacturers (SBIG included) use to protect the CCD chip. The result is a 'dust doughnut' —a ring on the image of reduced intensity visible in the background. (There is a hole what would be a disk due to the obstruction of the secondary.) It is easy to determine where the 'dust bunny' is—just multiply the physical diameter of the ring (= pixel diameter x pixel size x plate scale) by the focal ratio of your system. Then you can attempt to reduce (but never eliminate) the dust bunnies with careful cleaning.

The use of good flats can virtually eliminate problems from any of the above sources. A flat-field frame is simply an image of a uniformly-illuminated target. A series of 10-30 these is taken, bias and dark removed, and the set combined (usually by the median statistic) to make a master flat.

Master flats (and note that, if you are working with different filters, you need to one for each filter) can be made in a number of different ways:

a. Sky flats These are made by pointing the telescope at the zenith during dusk or dawn twilight. The important thing to remember is that, at dusk, there is an exponential rate of decay in brightness, so you have to be quick to make flats using more than one filter (there is a 5-10 minute window!). For very wide-angle system, sky flats are problematic because there is significant variation of sky intensity over the chip. Where appropriate, the advantage of sky flats is that the optical system for the flats is exactly the same as is used for taking data. The disadvantage is that one can only take flats with a clear sky at dusk or dawn (cloudy skies won't do!!) and one has an extremely limited time to do so. You also cannot take them if the sky is 'dodgy' at dusk.

b. Dome flats These are made using a suitable large surface (painted plywood, interior of the dome if you have one) evenly illuminated using flood lamps. Therein lies the problem, however. How does one ensure that the surface is evenly illuminated to a precision of 0.5% or better? You will certainly need to test by simply dividing flats from one method by the other. Differences of under 0.5% are the goal.

c. Light-box flats The author made a light box from corrugated plastic consisting of a straight walls and a top, short corner baffles (in the interior, at the bottom, and set at 45°), and a diffuser screen at the bottom. Into the corners, hidden from the diffuser screen but illuminating the top, were placed light bulbs. The interior walls were painted black to reduce extreme off-axis rays striking the diffuser screen. The top interior surface was a white disk (the same size as the primary mirror) surrounded by black. Comparison with sky flats revealed agreement to within 0.5% throughout the chip. A potentiometer was inserted in the power cord to adjust the light intensity as required for the different filters (dim for clear and IR filters, bright for blue).

In summary, the standard processing sequence for any image of the sky is three steps: bias subtraction, scaled (on the basis of exposure time) dark subtraction, and division by the master flat (which is normalized to unity on average across the field).

Software

There are many software programs that can control your camera and do the preliminary reductions described above. Here are some of the most commonly used Windows programs (in order of increasing cost):

CCDOps This comes with all SBIG cameras (and only works with them). It's pretty basic, but it will take exposures, autoguide, do filter changes, median-combine up to 3 images, do dark subtraction and flat-field. Most users will want to obtain more powerful software. (There are, however, also versions of CCDOps for 64-bit Vista, the Macintosh and Linux.) Visit sbig.com.

AIP4Win This is fairly popular software, in view of its reasonable cost and the extent of its features. It comes with the book *The Handbook of Astronomical Image Processing*, by Richard Berry and James Burnell (Willmann-Bell, 2000; about \$100); the latter is highly recommended. A free download version is reputedly available. Visit www.willbell.com/aip4win/AIP.htm.

Maxim DL This is a classy program of choice for most astrophotographers and some photometrists. It comes in many levels, ranging from \$199 to \$655, and does a ton of stuff. Visit www.cyanogen.com.

Mira A/P and Mira Pro. This is likely (in the author's opinion) the best photometry package on the planet. Written and marketed by a professional astronomer (who was sick and tired of IRAF, see below), it simply does everything you could want for image processing for photometry. (It will also handle astrophotography, but perhaps Maxim DL is better for that.) Its features include (but are not limited to): the usual bias-dark-flat processing (of up to 300 images or more at a time), cosmetic processes (using pixel masks, blemish removal, cosmic ray removal, etc), photometry, spatial filters, all kinds of image math, geometric processes, RGB processing, image statistics, diagnostics, centroiding, full width at half maximum, 3-D plots, scripting and more. Mira A/P sells for about \$299 and Mira Pro ranges from \$429 to \$639 (all in US dollars). Visit mirametrics.com.

IRAF If you have a Linux or Unix-based computer, you can install IRAF. It is free from

the National Optical Astronomy Observatories (NOAO) in Tucson, AZ. However, installation can be difficult and problematic and help difficult to come by. Once installed, IRAF is difficult to learn, poorly documented, and very confusing at times. It has been described by some as *user antagonistic*. On the positive side, it has many features and can be scripted (once you understand what you are doing), enabling automated processing involving many steps -- but so can Mira. For some unfathomable reason, it is the preferred package for most North American professional astronomers. Professional astronomers in Europe and the southern hemisphere have other packages.

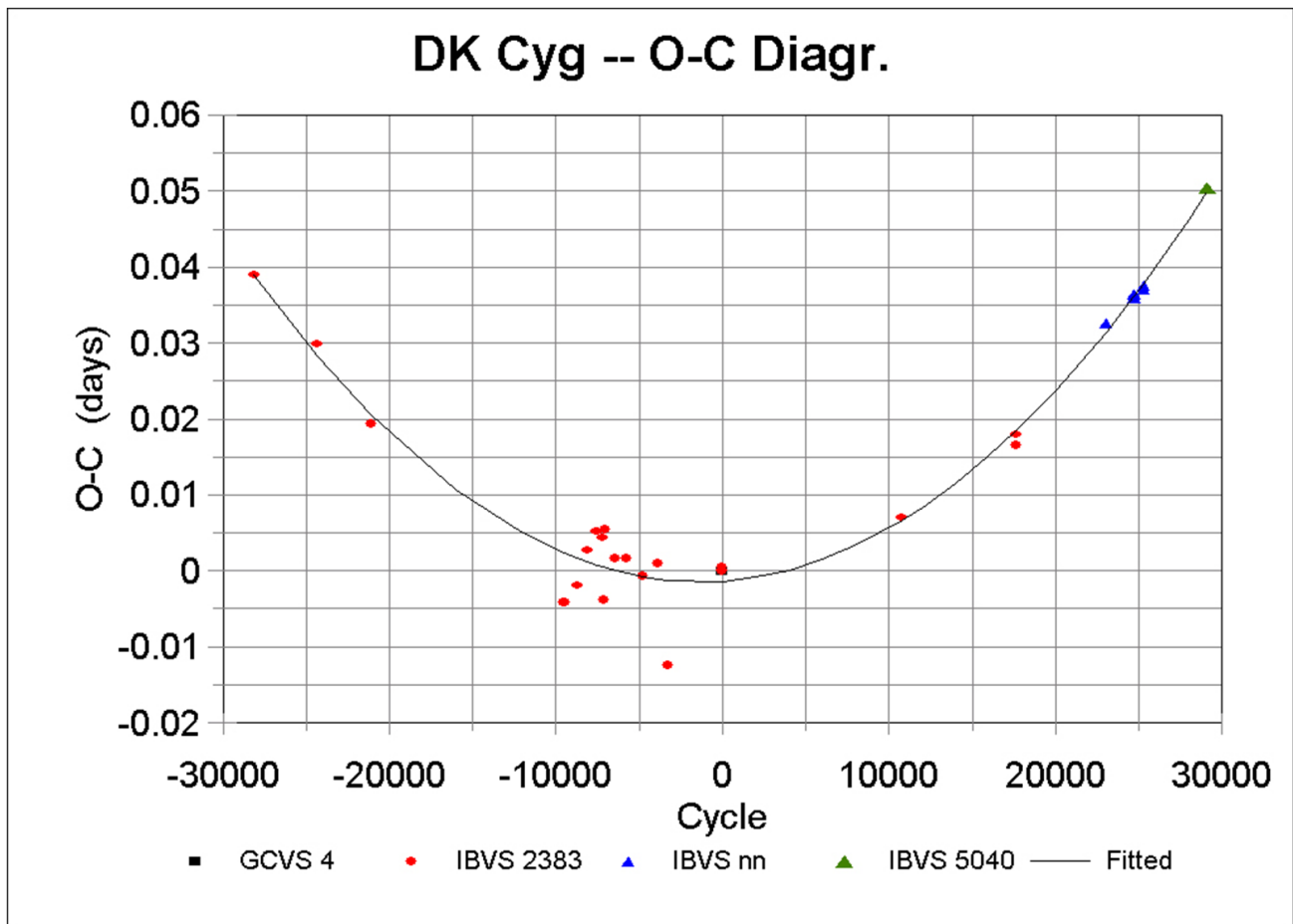
For a list of other software, visit sbig.com/sbwhtmls/softpage.htm.

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Cousins A.W.J. 1976, Mem. R. Astr. Soc. 81, 25

Part IV -- Determining Times of Minima



In this section, I shall describe in detail how to determine accurate times of minima (ToMs). Accurate determination of ToMs is important to keep track of possible period changes that will occur when there is mass loss (via the stellar wind, eruptive loss), mass transfer (from one star to the other) or the presence of a third body. These changes are displayed and analyzed with the O-C plot. But, more about that later—in February! In the interim—an example in DK Cygni’s O-C Diagram.

A BRIEF OVERVIEW OF THE PERANSO PROGRAM

Ranald McIntosh

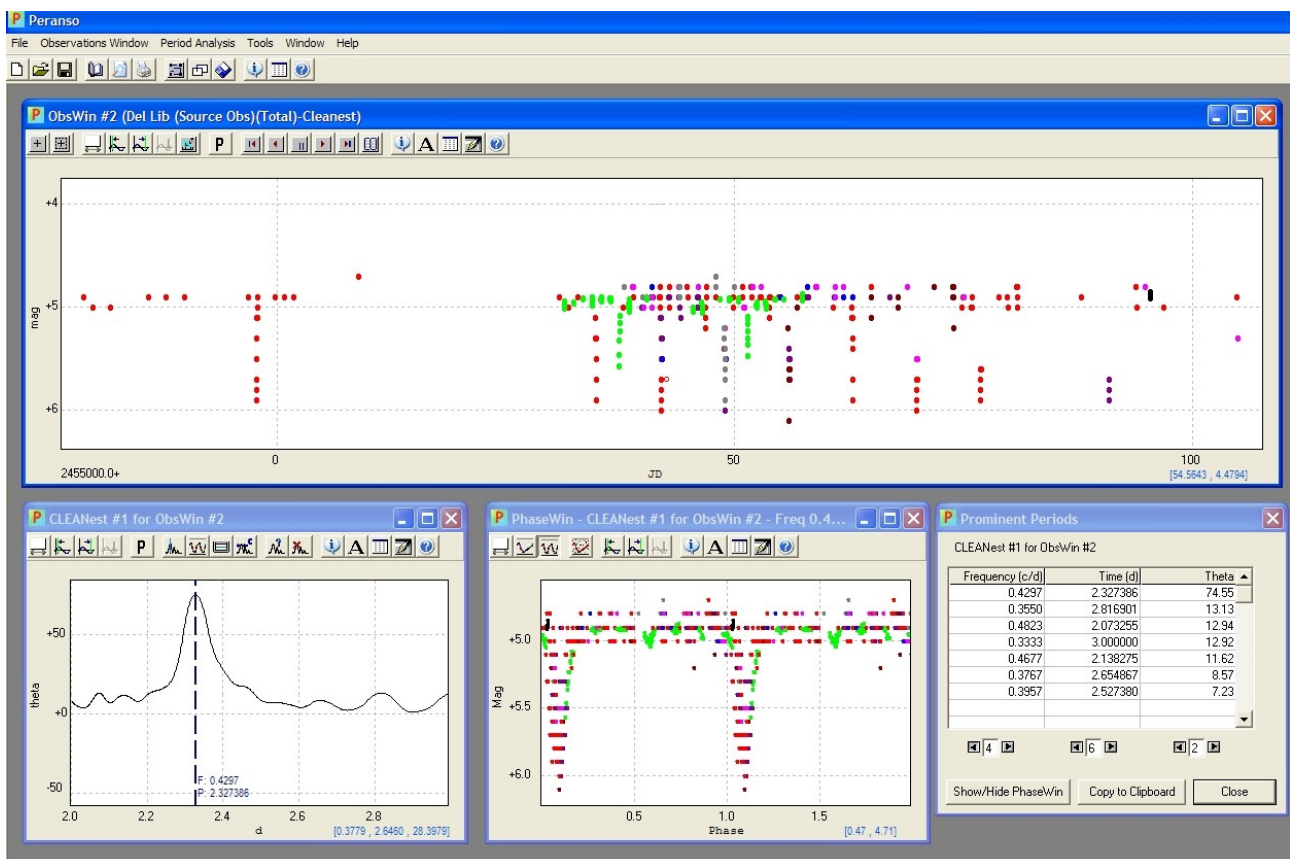
ranaldrm@es.co.nz

(See page 14 for photo of author)

There is currently a wide variety of software available for analysing variable star light-curves but one that really stands out, because of its ease of use and presentation, is **Per-anso** (Period Analysis Software).

The Main Features:

- Able to process datasets in excess of 300,000 observations. Data can be added if required at any stage.
- Stores data and images to a file or clipboard.
- Provides a comprehensive set of period analysis methods to help detect periodicities in time-series. These comprise various adaptations of Fourier Transforms plus a variety of statistical techniques (their operation is transparent to the user).
- Multiple windows can display the observation sets, period diagrams, phase diagrams plus other information.
- There are data analysis functions for averaging, de-trending, pre-whitening, helio-centric correction and polynomial curve fitting.
- Period error values can be determined.
- Selected observations can be temporarily deactivated to allow the study of the effect on the period analysis results. This is great for deactivating 'noisy observations'.

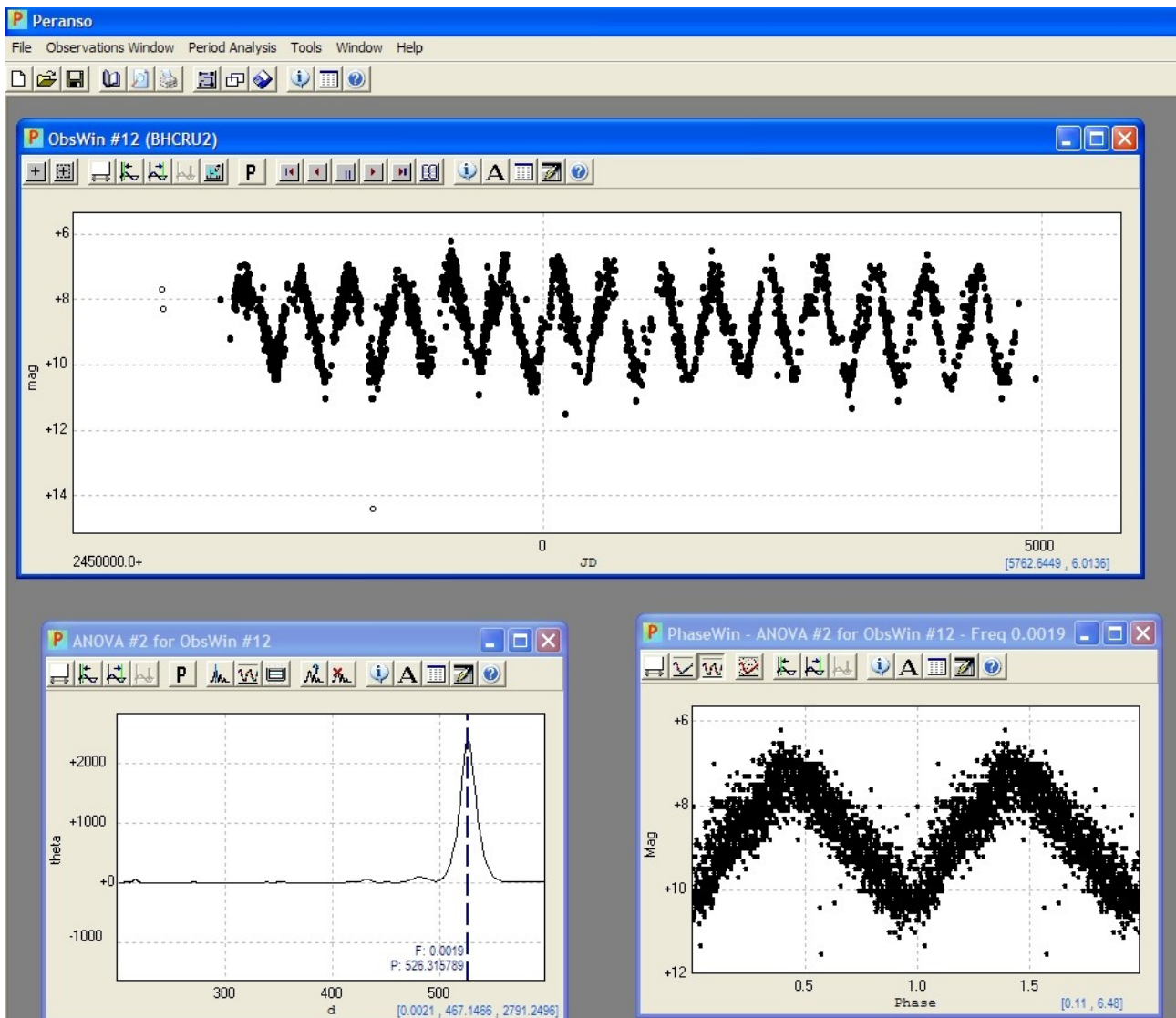


- Observations can be imported from Microsoft Excel, Microsoft Word, comma and space delimited files plus other formats. The data input utility is very flexible.

There are also other utilities and customisable features pertaining to the windows, graphical layouts and data processing.

Overall, this program is user friendly and a delight to use. The initial production of an approximate period for a light-curve is almost intuitive (for those who like to play before reading the manual). However, one has to be aware of aliasing and other mathematical artifacts produced by the techniques used, especially when using Fourier analysis techniques.

Where there is plenty of data, a visual inspection will give a rough approximation of what to expect. From that point on, the application of one or more of the methods available will home in on the periodicity of the light-curve. Several of the methods allow for progressive refining of the periodicity and can also assist in the search for multiple periods.

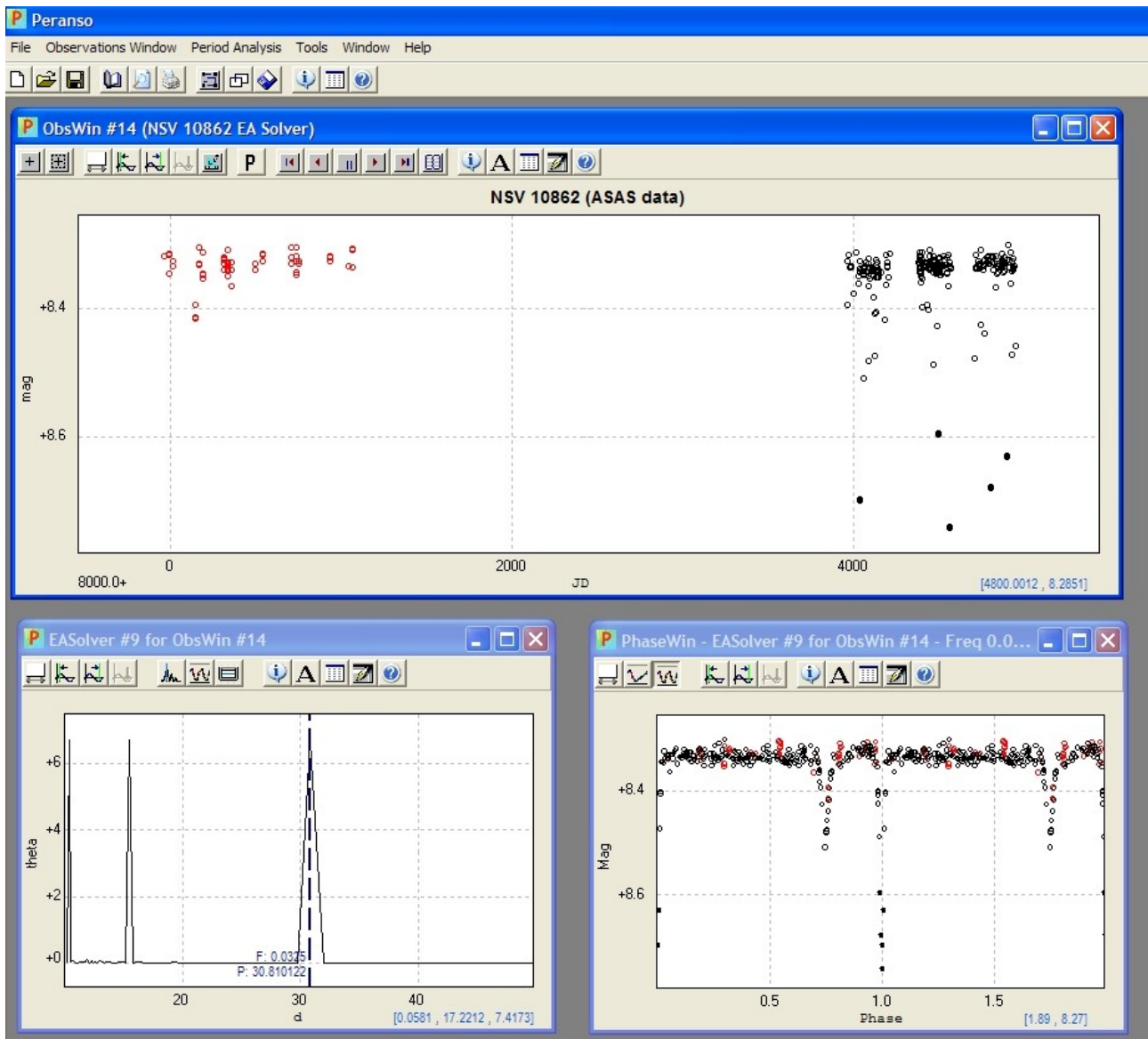


Where data is sparse, it is still often possible to obtain a good approximation of the periodicity if the right method is used.

The 193 page manual associated with Peranso is very comprehensive and can be downloaded from the Web in pdf format for free. Unfortunately, the size of the manual seems to put many people off, but a good portion of its content is actually a number of tutorials that use data, included in the Peranso program, to demonstrate how to use the various utilities and extract information from the light-curves. For better or for worse, I am a 'Manual Reader' and found that working through these examples clarified the operation as well as the philosophy of the program.

When I purchased my copy of Peranso some years back I immediately printed out the Manual and have used it since as a ready Reference. However, whilst the manual has a good index, using the word search facility in Adobe Reader is a plus at times.

The Peranso program can be downloaded from a number of web-sites, and it can be trialed for 14-days before it is necessary to 'purchase' and obtain a 'Key'. During the trial period the program switches off after 10-minutes.



MIRRANOOK OBSERVATORY ARMIDALE

Terry Bohlsen

I am only new as a member of the VSS but am keen to contribute to the study of variable stars. I am a country GP with an interest in astronomy that started in the mid 1990s. I had moved to NW NSW (Moree) for work and was attracted by the lovely open and dark skies. I bought a little 90mm ETX scope and was hooked.

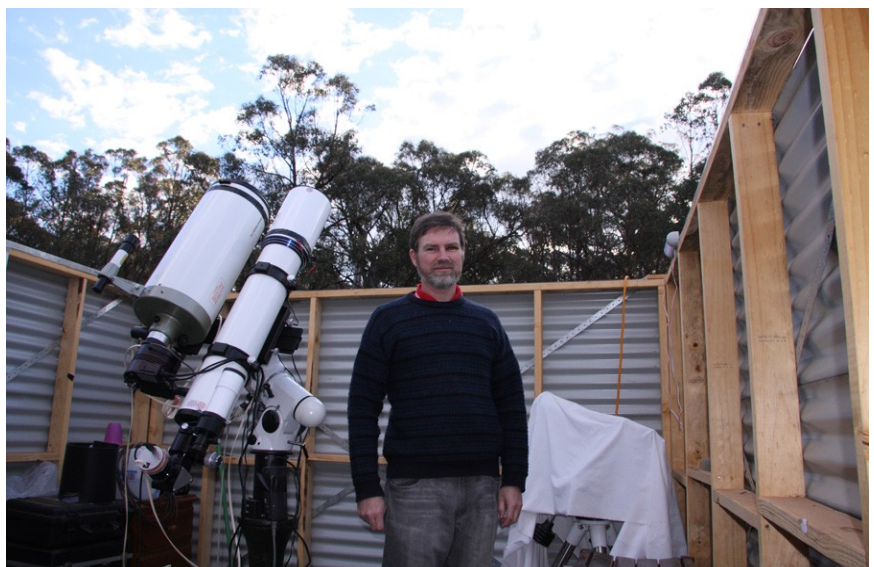
I enrolled in the second intake of the Master in Astronomy at UWS and this gave me a great background in astronomy. I met quite a few professional astronomers but had very little contact with any other amateur astronomers. My research for my Masters was with Miroslav Milosovic and a group of us produced a paper on radio sources in the SMC that used data from the ATCA and Parkes. Sadly the course at UWS folded for political reasons at UWS and most of the lecturers moved to James Cook Uni.

I built a small CCD based on the Audine CCD using a Kodak KAF0401E CCD to use on my scope. Commercial CCDs seemed vastly too expensive and this little CCD gave me a great intro into imaging. Taking pretty pics of the night sky is nice but I felt that it was pretty pointless just taking another image of a bright object to post on the web. I moved to Armidale in 2005 and was able to join the local astronomy group- something that did not exist in Moree. There I met Wes Hall (an avid visual variable star observer) and some others that started my interest in photometry.

I now live on a property (Mirranook) 12km west of town and have very dark skies. As I have the space I decided to build an observatory with the help of my brother who is a builder. I poured a slab for the first time since I was 18 and with his expertise we built a roll off roof observatory in a weekend.

It now houses my scope and CCD. I now have a vixen VC200L and a 127mm APO refractor mounted on an EQ6 mount. I use EQMOD to control the scope and have a SBIG ST10XME as my imaging camera with BVRI filters. The refractor doubles as a guide scope but can also be used to take pretty pics if I want.

My interest has been in measuring long period variables and to try to improve the accuracy of transforms, etc., in my measurements. This suits my lifestyle. Time series over about 2 hours is difficult when you have to work the next day so I rarely image after midnight. Hopefully I can contribute to the body of knowledge that the VSS aims to achieve.



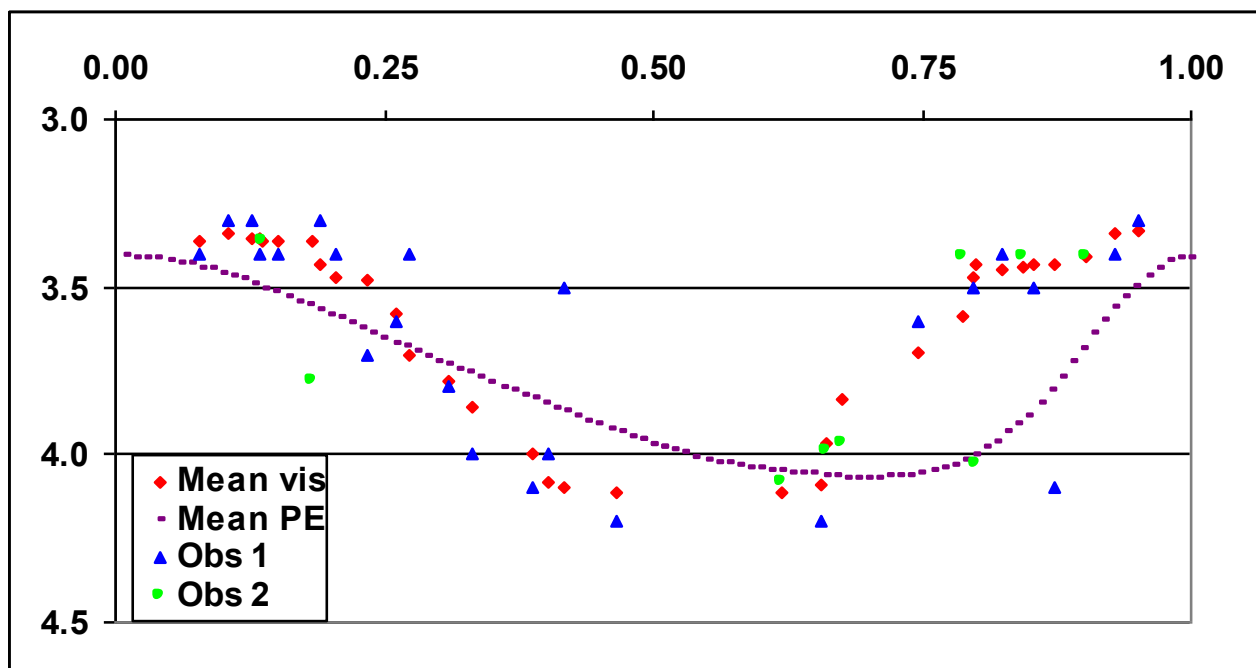
REPORT ON PULSATING VARIABLES

Stan Walker

stan.walker@varstars.org

You will have noted the disappearance of the Long Period Variables category from the website and substitution of a more general class of objects—pulsating variable stars. This allows more flexibility to allow projects which can address areas where visual measures can help fill gaps in the overall coverage of variable stars.

The website now contains a project targeting bright, longer period Cepheids which could do with more measures in order to study period changes. The analysis of *l Carinae* was difficult due to the various sequences in use—some observers even created their own—but we can now hope that we’ve seen the end of changes in comparison star values except when the comparison star itself changes. Not too many of these, I hope! The lists and comparisons are given in more detail there, but in summary there are 14 stars which are brighter than magnitude 6.5, have an amplitude of around a magnitude and periods in excess of 7 days. These longer period stars seem those most prone to change. The project has been experimental up to this stage but Aline Homes, Bob Evans, Glen Schrader and others have contributed measures. The most observed star has been *l Carinae* and a graph of these measures appears below.



The idea is to derive seasonal (one per year) epochs of maximum by fitting measures to a mean light curve and then displaying these on an O-C diagram. This is much more accurate than other methods and allows comparison with the historical record.

The graph is immediately interesting. The visual amplitude is a little larger than the mean photoelectric V range and the visual light curve is rather different in shape. With so few measures—both exact maximum and minimum have not been observed visually—the mean curve is not yet defined adequately. The eye sees differently to either the CCD or PEP detectors so there is the expected offset between the visual and PE measures caused by the red colour of *l Carinae*.

STUDYING SOUTHERN VARIABLES COLLOQUIUM – PART 2.

Carl Knight.

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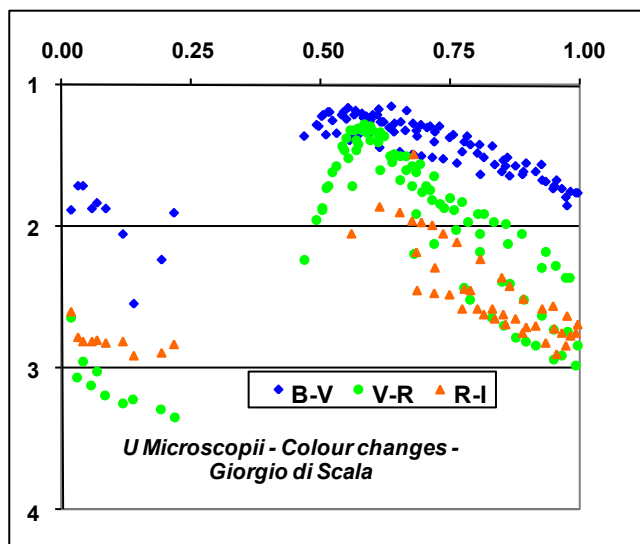
Stan Walker – Near Infra-Red J & H Band Photometry at Wharemaru.

Stan resumed the after lunch session with a discussion about investigating stars at IR wavelengths of 1.3μ to 1.8μ . The topic was quite fluid, this reflecting Stan's enthusiasm, and the fact he rightly points out that there is still so much to be done.

Previously Stan and other members of the Auckland Astronomical Society had made several thousand measurements of Mira stars using the Mark I UBV Photometer at Auckland Observatory over a period of 20 years commencing in 1968. He points out that whilst there is criticism of using a largely blue sensitive system with Miras, these criticisms are groundless. Stan further states that "UBV provides temperatures, measures of the gas shell and a very accurate measure of light variations."

On his current project Stan has made use of an AAVSO loan SSP4 NIR photometer. The basic idea is to track the colour changes in Miras, and to fit these changes to the UBV light curve initially and then J & H IR bands (JH) a few days after the peak in UBV as the peak in JH lags that in V. This is illustrated in Figure 1 where the B-V peaks before V-R and similarly V-R before R-I. I.e. Longer wavelengths peak after shorter wavelengths.

One significant limitation of the loan IR photometer is that it is rather insensitive and is



largely incapable of measurements below magnitude 4 or so. However, this is compensated for somewhat according to Stan, by the fact that Miras are very bright at these wavelengths, indeed brighter than Sirius in many cases. For example, α Her is magnitude -2.45 in J!

A further more general restriction is the equipment that different bands require. UB, BVRI and JH are all within the reach of the amateur and small observatory. Longer wavelengths like KLM require yet more specialised equipment and so fall

into the domain of the professional astronomer.

The author—Carl Knight

There are many stars bright at JH, indeed many are naked eye stars, and the sky makes no contribution in these bands. Colour can be quite deceptive. There are red variables that are not at all bright in these Near Infra-Red (NIR) bands, whilst others are very bright. For example, the LPV ν Pav is bright at JH whilst its cousin, S Sct is not. Very red carbon stars like T Ind and V Pav are also not bright at JH.



Owing to the brightness of these variables, getting suitable comparison stars is difficult. Stan states “there are only 49 stars with V magnitudes of 2.0 or brighter in the whole sky.” Colour matters when it comes to finding suitable comparison stars. With respect to the stars that Stan is measuring, he has found only 37 suitable comparison stars in the southern sky, of which more than half are suspected of being variable, and ...“in an area of 25,000 square degrees (to about 10N) there are about 50 usable comparisons. Thus on average the nearest comparison is about 22 degrees away.”

K and M stars for comparison are more stable but not as bright in IR JH bands.

In answering why he is doing this, Stan says he is interested in moving beyond the periods of these variables and looking at the physics of these stars. The area of interest is the same as that covered in Stan's prior Colloquium presentation, that is, well evolved low mass stars “assorted red variables. Miras, SRs, LPVs, SARVs, Irregulars.” He is seeking to identify which is which, what order these types appear in in the overall evolution of the stars they originated from and what do the in between stages look like. In Stan's own words “Maybe we can bring a little order out of the seeming chaos in the red variable area of the H-R Diagram?”

Almost as an aside, Stan pointed out that whilst Mira itself peaks in JH, the relationship between the emissions at these bands remains relatively constant. What does that tell us?

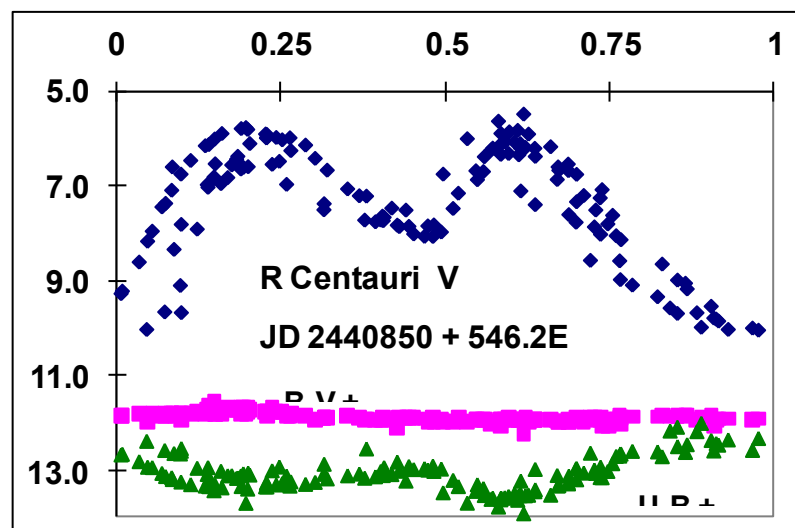
Stan also answered one of the author's questions illustrating the physics that can be revealed by the colour measurements he is making. Referring to Figure 1 the lag between short and long wavelength peak emission he explained that this lag suggests that there is absorption and re-emission at longer wavelengths in the region surrounding stars like U Mic.

A typical Mira has an immense gas shell which is responsible for its characteristic spectra, and an even more expansive dust shell. This dust shell is very likely seen in the IR and NIR.

Referring to his morning presentation (footnote 1 above), Stan touched again on the topic of LPV period changes, but moved on to explain other areas of interest in LPVs. For example, the relationship light and colour curves of R Cen whilst it was still displaying a pronounced double maxima.

It is suggested that the B-V and U-B colours reveal a hotter blue companion.

Explaining the dual maxima it is further suggested that the true period might be half the currently accepted 546 days, or that the first overtone and fundamental have an exact 2;1 ratio – “...which is correct?”, asks Stan.



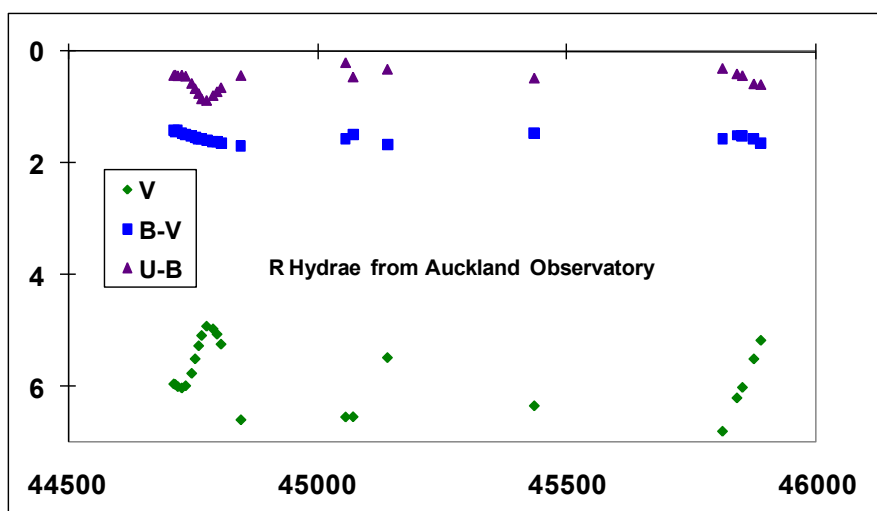
Collaboration and project outline.

Another star showing unusual colour changes that Stan used to “tease” his audience (his “sales pitch” to generate further interest) was R Hya. It exhibits “...tantalising indications of unusual colour changes.” Stan is keen to locate further measurements to fill in the gaps for R Hya.

Collaboration is key for work like this. More measurements are needed. At the time of the Colloquium, Stan was hoping to further search the international database and was hoping to find further measurements made by the likes of Giorgio di-Scala (e.g. Figure 1) and others.

Posing the question, “What will we find?”, Stan answers, in effect, nothing at all if we don't try!

Whilst Stan believes that the measurements for any project will most likely finish up in the AAVSO database, he points out that the AAVSO does Time Series Photometry and not the sort of colour measurements that Stan's work requires. To that end, the collaborative work must maintain its own database.



Stan proposes that the project will work on 20 – 40 stars at a time, and that as each star is adequately (adequate defined by the period of the star, i.e. capture sufficient cycles for the data to be meaningful) measured, the project will move on to another star.

Professional input is also sought to provide the necessary theoretical grounding. Publication is also vital. Stan points out that a group he was part of in Auckland using one UBV photometer managed to publish two or three papers a year for 25 years.

See also, “Stan Walker – Colour measures of unusual stars.” later in this report.

Marc Bos – Teaching an old dog new tricks.

Marc's presentation documented his journey into fine engineering as he sought to produce a telescope mount to meet the exacting requirements of doing photometry of faint objects in crowded fields. To achieve this goal he needed to improve pointing, tracking, guiding and to use digital setting circles.

Previously Marc had a German equatorial mount built with inadequate tools in 1989. It had no setting circles. In 1997 he fitted setting circles, rebuilt the drive and did more precise engineering.

In 2006 Marc overhauled and rebuilt the mount. He added encoders into the mount.

Added an Argo Navis unit and anti-backlash mounting. All this was done using off the shelf components.

Marc was at pains to explain how flat is flat when it comes to engineering surfaces that must rotate against other surfaces and not introduce tracking error in the mount.

Single star alignment with Argo Navis is possible if the mount is in proper alignment.

Marc uses a Maxim-DL image link to get the exact pointing right. The fields he is doing photometry in are too crowded for star charts.

Marc has build his own CCD camera and uses a 12" Meade Classic SCT.

Bill Allen – Eta Carinae.

Bill Allen has 38 years worth of photoelectric observations of Eta Carinae. Currently he works from his Blenheim, NZ based Vintage Lane Observatory which also houses the Boötes-3 Telescope (Figure 6).

η Car is located in the centre of the nebula of the same name, in the NGC— it is NGC 3372 (Figure 5).

In 1843 η Car outshone Canopus at magnitude -0.86 before fading in the 1900s to magnitude 7.5. It has been steadily brightening again since the 1940s and is now around magnitude 4.95. This is shown more clearly in Figure 8 below

Bill treated us to a quick summary of η Car facts:

Eta Carinae is one of the most massive and luminous stars in our galaxy

100 solar masses

5,000,000 times brighter than our sun

7500 light years away

Close to "Eddington Limit"

Supernovae candidate?

Suspected binary

Old and new.

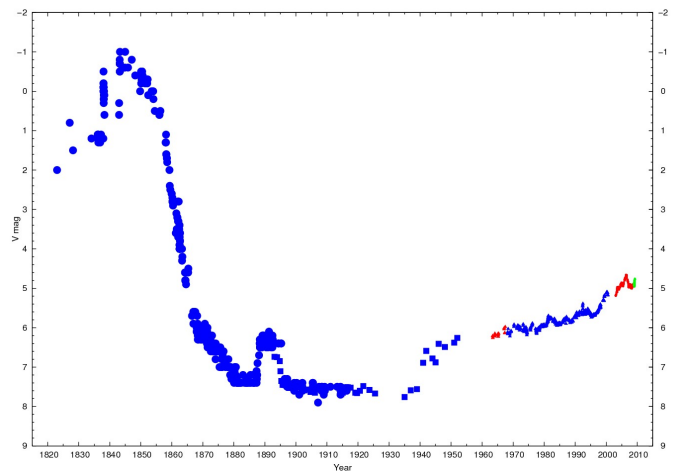
Bill would appear to not be one to ever waste anything. His equipment includes an Apple IIe computer. He is using:

Photomultiplier EMI 9789QB

Johnson U B V filterset

Automated filter wheel





Output “Rowe” current to frequency converter

Control computer is an Apple IIE

High tech insulation tape to hold things together (Figure 7)!

For anyone interested in a project to monitor η Car, see “Alan Plummer – Eta Carina Project.” later in this report.

Grant Christie – Microlensing.

Grant's observing program uses a Meade 16” on a Paramount. It's focus is on:

Gravitational Microlenses (GM) – Part of the MicroFun Project, Ohio State University, USA.

Gamma Ray Burst (GRB) afterglows. Böotes-3 (See Figure 6 above).

Comet and Near Earth Object (NEO) Astrometry.

Cataclysmic Binary Stars (CBS).

Gravitational Microlenses.

According to Grant, GMs achieve magnifications of 1000 to 1500 times. A typical lens event lasts 10 to 100 days. The magnification is greatest if the alignment is exact.

The region of the Milky Way where Grant spends his time hunting for GMs is the galactic bulge. The greater star density increases the odds of finding a GM.

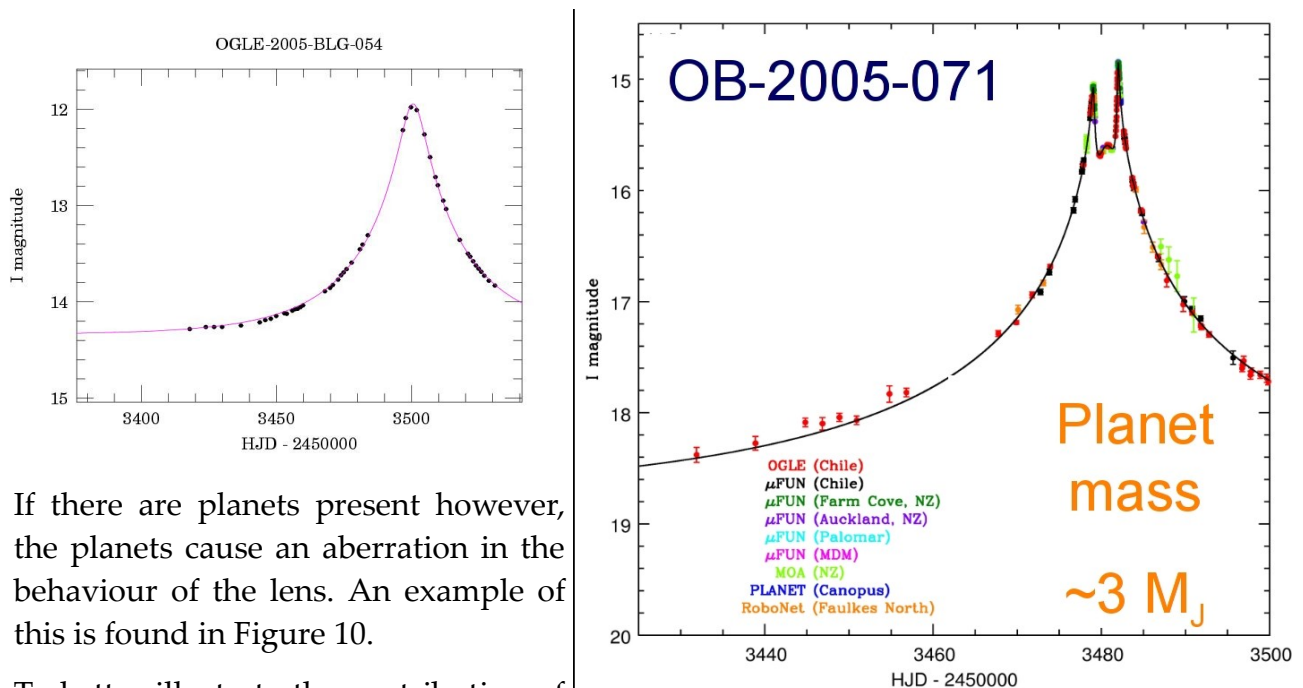
Surveys monitor something in the order of 100 million stars. This leads to the detection of around 700 events per year and for these events alerts are issued.

Grant has been using Maxim DL and reports it is quite robust. The telescope used is a 16” Meade LX200R

Using Gravitational Lenses to detect Exoplanets.

When a GM occurs with about a star with no planets present, the light curve simply

shows an increase in amplitude and then a corresponding decay. This is illustrated in Figure 9.



If there are planets present however, the planets cause an aberration in the behaviour of the lens. An example of this is found in Figure 10.

To better illustrate the contribution of the Exoplanet to the lightcurve of the lens we can well imagine (Figure 11) that the position of the Exoplanet in its orbit over time will result in it having a varying contribution to the overall magnification achieved. When it is better aligned (from the observer's perspective) in its orbit to the source being lensed, it will cause an enhanced peak, similarly when it is not so well placed such a peak will be absent.

Discoveries.

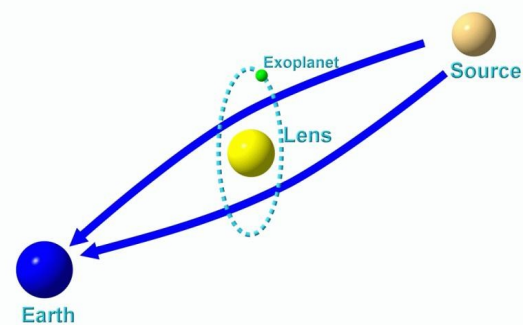
3.8 M_J 2005

13 M_e 2005

1 M_J and 1 M_s 2006

At the time of Grant's presentation, the project had discovered 9 Exoplanets.

Grant said that possibly 5-155 of GMs might indicate the presence of planets and that incredibly accurate parallax measurements out to 20kly are possible.



DISCUSSION SESSION

Alan Plummer – Eta Carina Project.

Alan kicked off the discussions outlining his proposal for an Eta Carina project. Participants will be beginners and the project will aim to publish results. It will be a one year project for now and focus on η Car and R Car. There is plenty of historical data according to Alan. Light curves generated from the observations will hopefully provide some in-

sight into the stars in question and at the very least the group will publish a popular piece – if not scientific.

There was lively discussion on the topic of how to handle data and whether or not personal equations would be of use.

Starter Kit. Fields prepared, comparison stars, calculations with non-variables to help people get it right. Charts for the project are RASNZ chart number 1 for R Car and the AAVSO VSP for η Car.

Tom Richards – EEB Project.

This project is to be a collaboration between the BAA VSS and the RASNZ VSS. Des Loughney of the BAA and Dr Bob Nelson from Canada are liaison for their respective organisations.

The motivation for the project is that ECBs are understudied. Many lack periods. There is data from the first half of the 20th century, but that's it.

Tom suggests that the first step is to find minima. Targets will be:

- Bright at minima, brighter than magnitude 13.

- Near the celestial equator.

The project's members will probably be organised into three zones: Europe' Australia/New Zealand and the Americas.

Targets will be allocated to given telescope/detector combinations based on suitability.

Analysts are required to:

- Analyse data.

- Produce an accurate ephemeris.

- Research on line data.

- Publication preparation.

Participants will get their own personal list of stars to cover. Many lack good comparison stars.

Time series of observations during predicted eclipse are particularly important.

Stan Walker – Colour measures of unusual stars.

The project is to make sustained colour measurements over long periods, ten years later or more. The intention is to look for changes in the evolution of the star.

Stan also referred participants to the ECB project that he proposed in the February VSS Newsletter. This project involves four stars in QZ Car. In this system the secondary pair causes elliptical distortions in the primary pair. There are huge differences in eclipse times as due to the size of the system. These differences are typically ± 7 hrs.

Finally Tom Richards brought the colloquium to a close and in particular thanked:

Pauline and Brian Loader.

The RASNZ Conference Committee and the local organising committee.

Frank, Mike and Bill.

Stan and Bill, his fellow organisers.

All of the colloquium presenters.

1. See the Author's previous report:

Knight C. R. (2009). Studying Southern Variables Colloquium – I.
VSS Newsletter, 2009(3), Retrieved from http://www.varstars.org/DownloadFiles/NL_2009-3.pdf

2. Something the author remembers fondly from his High School days over 20 years ago now.

NOVA ERIDANI 2009

There has been some interest in this last—perhaps?—nova for 2009 as it was originally suspected to be a WZ Sagittae variable—a dwarf nova similar to an SU UMa object but with extremely long intervals between outbursts.

Recent spectroscopy shows an expansion velocity of ~3400 km/s and characteristics of a classical He/N nova. This is confirmed by NIR measures, also by the B-V colour of -0.18. The amplitude, assuming that the identification of the pre-nova is valid, is about 9 magnitudes.

It's fading at present but not fast and is worth following through the summer. Maybe it's too much to hope that it will be another nova Dephini (HR Del) which faded and brightened in an erratic manner for months. However, Terry Bohlson's short monitoring run showed some unusual features and it's worth the occasional monitoring run.

Theoretically it shouldn't be possible to see much through the gas/dust shell at the moment and in due course a periodicity of 3-6 hours is likely to be found.

TT ARIETIS

This star has also been in the news a bit—Stephen Hovell sent me some graphs a few weeks ago—and is an excellent example of why visual observations of these stars are valuable. Not just one measure to warn of an outburst, but continued measures every few hours on a night when it's active to provide an idea of what it's really doing. This star has been called a Z Cam object but this is apparently incorrect and a more likely classification is NL or novalike—whatever this means in reality. So put this one on the list if it's not already there. It may be a bit faint at this moment, but keep watching for it. There's an interesting light curve on the AAVSO website.

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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. It needs to be expanded a lot more however, and suggestions should be sent to the webmaster.

All VSS members should belong to the VSS-members egroup, as that is the main channel of fast communication between members. If you're a VSS member and still haven't signed up to it, please go to its home page (above) and apply.

MEMBERSHIP

New members are welcome. The annual subscription is \$20NZ, and the membership year expires on April 30th. Find out how to join by visiting the VSS website at <http://www.varstars.org/Join-VSS.html>. There you will find out how to join by post, email, or directly online. If you join by email or online 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, do please sign up to the VSS-members egroup (see above). In its personal information section, it would help everyone if you added information about your telescope and equipment, your astronomical interests and anything else you consider appropriate.

NEWSLETTER ITEMS

These are welcomed and should be sent to the Editor. I'd appreciate them unformatted, although if you wish a particular layout and a formatted version and we'll ensure that this is followed. Publication dates are February, May, August and November—the twentieth of each of these months and the copy deadline is the first of each of these months.