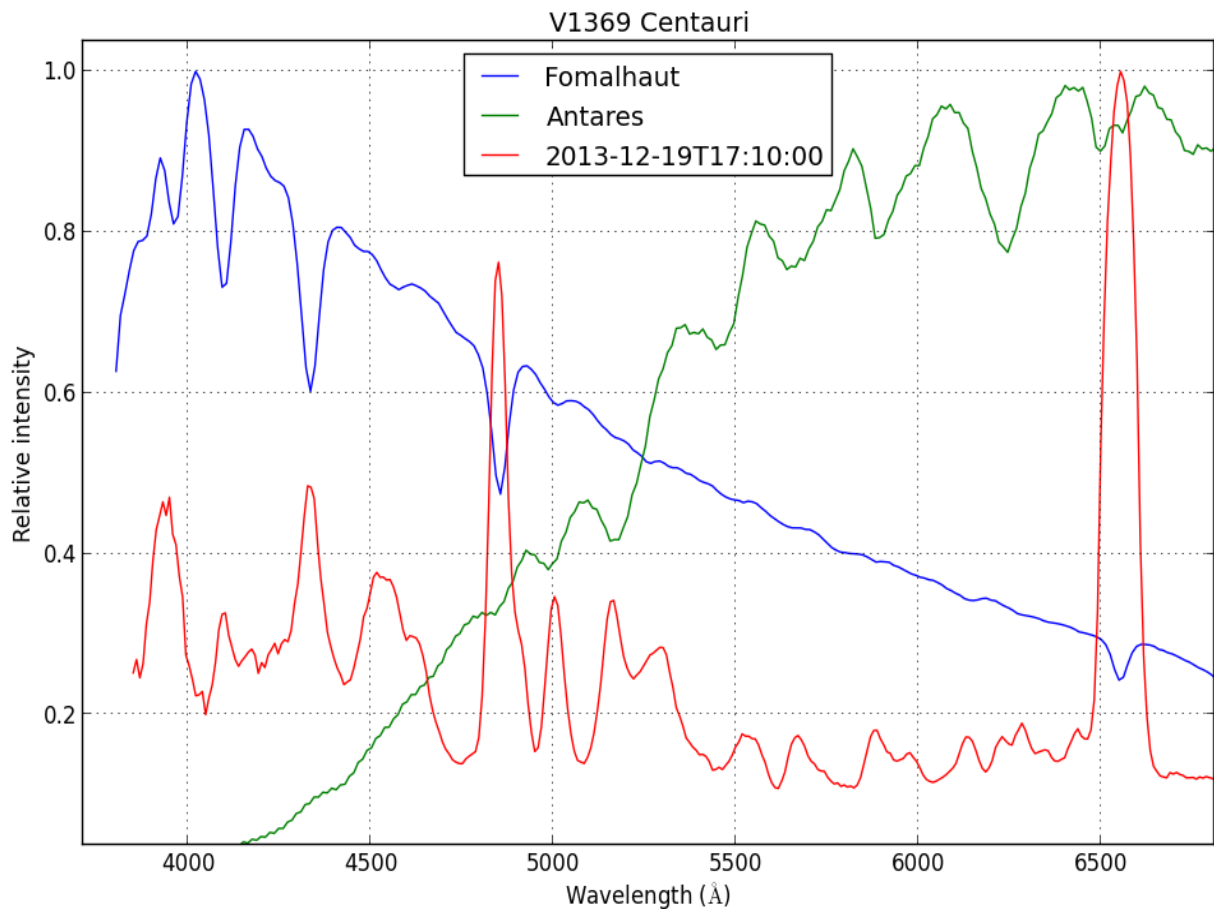




V1369 Cen spectrum alongside similar resolution spectra of Fomalhaut and Antares. V1369 Cen spectrum — Jonathan Powles. Fomalhaut and Antares spectra — Malcolm Locke. See article page 9

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From the Director – *Tom Richards*

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Whakatane 2014– the Mecca for variable star researchers

Everybody who's anybody, in southern VS research of course, will naturally be in Whakatane, New Zealand, this June. Not only do we have **Variable Stars South Symposium 3** on **Monday June 9th**, but preceding that the **RASNZ Conference** on Friday night to Sunday **June 6th-8th**.



VSSS3 call for presentations – your symposium needs you

VSS seems very busy right now, with the pro-am photometry/spectroscopy pilot on Zeta Pup, gearing up for the periastron of Eta Car, and the wide collaboration on V1369 Cen – the naked-eye Nova Cen 2013. That's in addition to pursuing pulsating eclipsing binaries, the rise of spectroscopy on other fronts, and the many ongoing projects. These all need presenting and discussing, at VSSS3 or the main conference, and I hope those involved will air their work and results.

We can keep the format of the symposium fairly free-wheeling – so long as we can fit everything in. Please email proposals for presentations of any sort to me by **April 1st**. I know that sounds a little early, but at Easter there's NACAA, then I'm in Europe until immediately before the conference. So I really need to sort out the programme in early April.

Give me a title, author/presenter names, and what sort of presentation it is (poster, talk, group presentation, short workshop...). Please include a one-paragraph abstract. We will have wi-fi internet access, and a computer and projector and whiteboard. Any special presentation needs beyond that? And don't worry too much about having the final form of your presentation figured out when you send me your proposal – flexibility rules, OK? But not on the deadline!

Then there's the RASNZ conference too

This is an important opportunity to demonstrate by poster or talk our variable star research to a much wider audience, and to show the vigour of VSS activity. We have plenty of stories to tell!

Go to <http://www.rasnz.org.nz/wiki/doku.php?id=conference:start> for registration, submission, and everything else. Proposals deadline is **April 1st**, the same as for VSSS3. See you there!

But first – NACAA!

Easter in Marvellous Melbourne, the World's most Liveable City, yet again! (You wouldn't know it today, it's 43C outside!) **Friday to Sunday April 18th to 20th**. Too late now to offer a talk, but poster submissions are open till Feb 1st. And if you're into occultation work, the eighth **Trans-Tasman Symposium on Occultations** is on Sunday afternoon and Monday.

There's a great line-up on variable stars and related topics. The draft programme includes:

- *Margaret Streamer "Delta Scuti-type pulsating stars in eclipsing binary systems"*
- *Roy Axelsen, "From light curves to light elements: new ephemerides for the Delta Scuti stars RS Gru and BS Aqr"*
- *Tom Richards, "It takes Two to Tango: the Intertwined Lives of Close Binary Stars"*
- *David Moriarty, "Pitfalls for Unwary Photometrists of the Understudied Southern Eclipsing Binaries"*
- *Chris Rudge et al, "Project Exo Planet"*
- *Donna Burton, "Spotty Stars"*

- Mark Blackford, "Variable Star Photometry with a DSLR Camera"
- Peter Nelson, "BSM South"
- Wayne Roberts, "Life and Death of Stars – Part two, Neutron Stars."
- Peter Norman, "The Nucleosynthesis of all Elements by a Supernova"
- Col Bembrick, "Eclipsing Binary Modelling Progress" (Poster)

Looks like it will be a good one. To register and find out all about it, go to <http://www.nacaa.org.au/2014/about->

RR Lyrae project is on ice

In the last two Newsletters Stan Walker proposed a project on the interesting short-period RR Lyrae pulsators. Unfortunately no-one has put up their hand to run the project. With one notable exception, that is – but his astronomical commitments ballooned so he realised it was best not to take it on.

So for now the project is shelved. But if you want to take it on, read Stan's article then email me.

Discovery/recovery of new Mira variables. – *Mati Morel*

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This is a brief report on my current project. Several years ago the late Albert Jones sent me a box full of old copies of the German journal *Mitteilungen über Veränderliche Sterne* (Notices on Variable Stars), dating back to the early 1960s. For years they were neglected as I thought there would be nothing of relevance to southern observers. I was wrong. Very recently I decided to go through these papers to draw up a list of stars with finder charts, and any photoelectric studies. One never knows what may be discovered.....

After less than one day I came upon two papers by H Wilkens (La Plata), announcing discoveries of new variables, in the vicinity of Omega Centauri (15 variables) and NGC 3201 (10 vars). Both of these objects are galactic globular clusters, of course, and the new variables were thought to be RR-Lyr variables. By scrutinising these old discoveries using 2MASS and ASAS-3 I have found two new Mira variables, hitherto unrecognised, one being near Omega Cen, the other near NGC 3201. The variable near Omega Cen is completely absent from the GCVS, VSX and SIMBAD, as well as the DDO catalogue of variables in GCs, in spite of it being reported in 1965. The reason for this will be explored in a future paper. The variable near NGC 3201 is a fairly bright Mira variable, reaching 11th mag (vis), but not known as a Mira variable up till now.

After one day of work, under trying weather conditions, it's pleasing to have hit some sort of paydirt, in the limited number of examined papers - two Mira variables and one irregular type. When I've gone through all of Albert's copies of MVS, hopefully within a few weeks, these new discoveries will be written up in a short paper.

Introduction

The last few months have seen two novae which have been observed in considerable detail by our members. In many ways the scene has changed dramatically since my first nova observation, that of Nova Delphini 1967 in the winter of 1967 on a showery night in Auckland. At that time variable star astronomy was being reintroduced to the Auckland Astronomical Society and we couldn't have wished for a better star to begin with. Now known as HR Delphini its visual light curve is shown in Figure 1.

HR DELPHINI - INTERNATIONAL DATABASE MEASURES

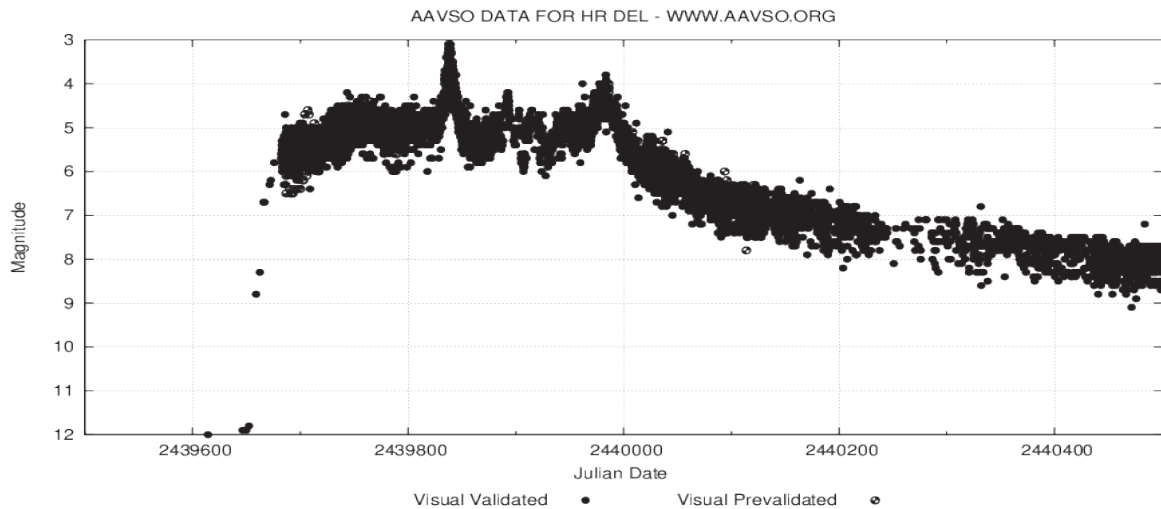


Figure 1. HR Delphini, this was a very slow nova, rather unusual in that it remained near maximum for almost a year, with two prominent peaks. The graph covers 1000 days.

Nova Delphini 2013 shows a different presentation with a variety of data at different wavelengths. The advent of PEP and CCD now allow a much more informative light curve to be secured.

V339 DELPHINI - INTERNATIONAL DATABASE MEASURES

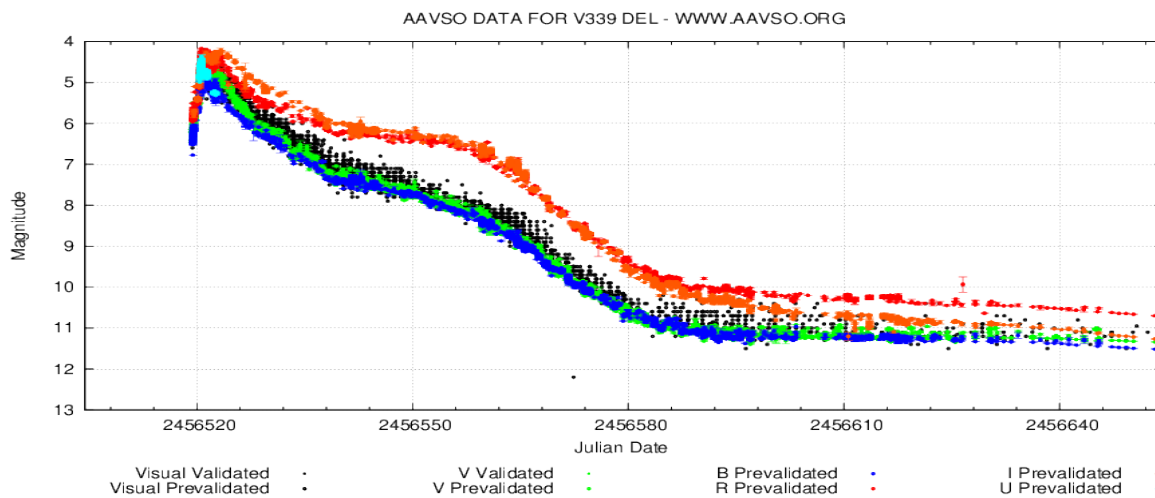


Figure 2. UBVRI measures of V339 Delphini (Nova Delphini 2013) over 150 days to 28 December, 2013. In these multi-filter graphs black markers are visual, light blue are U, dark blue B, green is V, red is R and orange I.

There are probably about 80,000 measures in this graph indicating the popularity of this object - although a large percentage of these measures were monitoring at 10 second or similar intervals in an attempt to find short-period regular fluctuations. The most noticeable feature here is the much greater brightness in R and I after 15 or so days when the expanding shell was re-radiating energy in the near infra-red, with probably some contribution from a hydrogen alpha emission line.

The third nova of interest here is a bright southern object, V1369 Centauri. It has not been as well observed as we would like due to its low altitude in the south eastern sky and the normal unsettled weather of early summer in the south. But it presents an interesting light curve with substantial fluctuations.

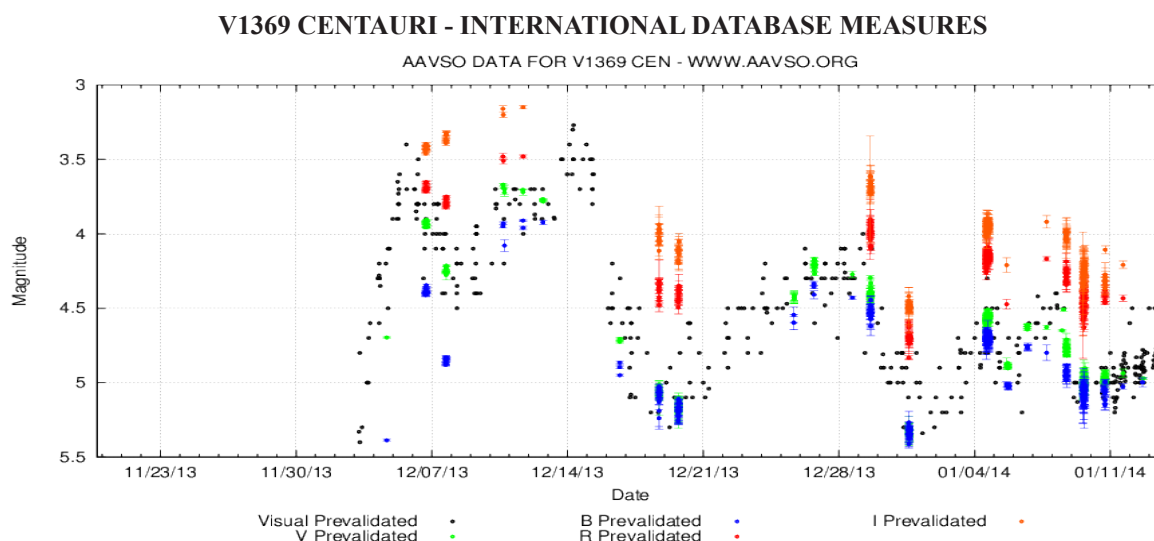


Figure 3. BVRI measures of V1369 Centauri to 15 January, 2014. The markers are the same as in figure 2. As expected it is brightest at this stage in R and I, but the B-V colour shows some interesting changes - from about +0.7 shortly after maximum to lesser values. Once again some monitoring runs are evident as vertical bands of measures.

Observing this nova

Variable Stars South welcomes as many measures in all areas of amateur observing as possible. These will be displayed on the website, which is now found at <http://www.variablestarssouth.org/research/by-technique/ccd-photometry/v1369-centauri> with sections on photometry and spectroscopy with room to add more. Since it is very bright CCD observers should stop the telescope aperture down to about 60cm using a cardboard mask loosely fitted in front of the corrector plate. Unfiltered measures of any type are of no value in the early stages of the event. Visual measures are easiest and approximate the V filter. Measures should also be sent to the International Database, maintained by AAVSO.

With the large velocities involved it's realistic to make measures of the expansion velocity with small amateur systems. This is in addition to the normal recording of emission and absorption features. An expansion velocity of 1000 km/sec will show a blue shift of 20Å at 6000 Å.

The physical nature of novae

It took a long time for the nature of novae to be found out. Even in the 1950s some astronomers were still exploring different element abundances in the envelope as the fundamental mechanism but at that time it was becoming apparent that the solution was partly mechanical in that the cataclysmic variables all seemed to be binary systems of a certain type; not much later it was realised that the other important aspect - nuclear burning of accreted material near the surface of a white dwarf star - supplied the ejection mechanism of the nova shells. Once the accreted material was forced into the hot regions of the isothermal core, $\sim 10^7$ K, nuclear fusion would occur at a level where the envelope would be unable to contain the

released energy and this envelope would, in part, be ejected.

Let's look at the components. In Figure 4 are depicted the main parts of a polar, a CV where a disc does not form due to magnetic fields so the white dwarf and the donor star are easier to visualise. Masses are in the order of 1.0 and 0.4 solar masses (highly variable in different CV systems) with the disc, which would lie in the plane of the system, having a mass millions of times less and being of little consequence in the nova event.

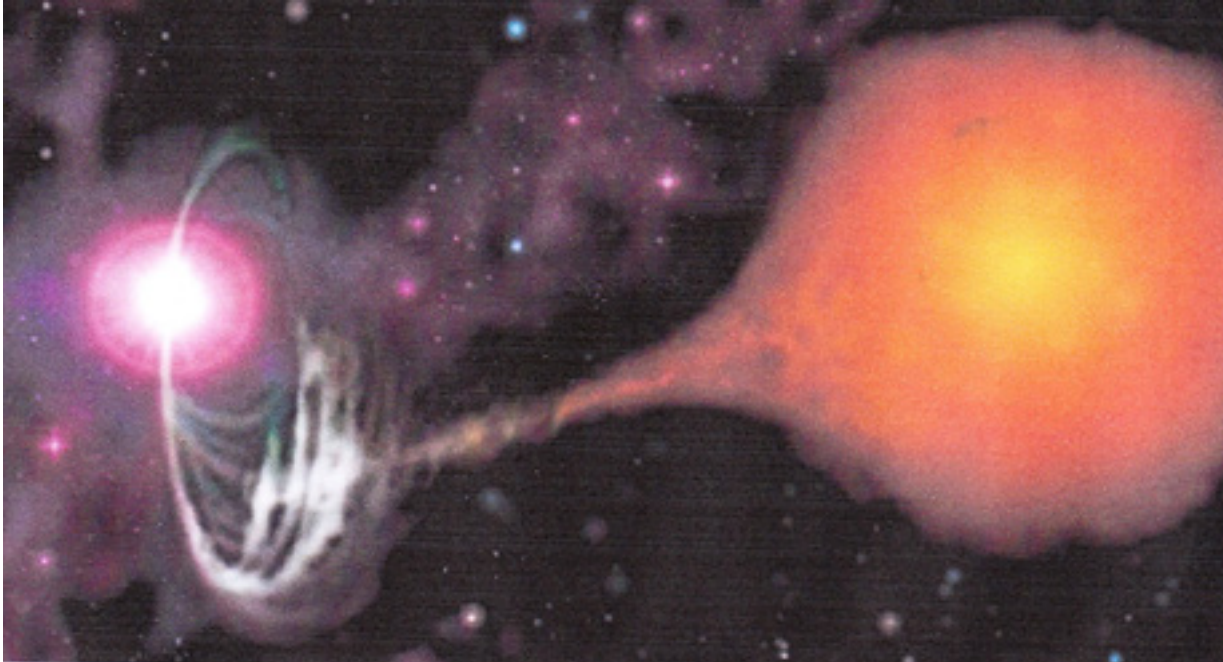


Figure 4. Relative sizes of the components in a nova system with the disc omitted. The white dwarf would be the inner part only of the fiercely radiating object at the left.

The nova outburst

A light curve based on the average characteristics of many novae (compiled by McLaughlin, 1960) is shown in figure 5. The system brightens quickly by about 10 magnitudes, a factor of 10,000 times, undergoes a brief pause, then rises another two magnitudes or so to end up about 50-100,000 times its quiescent brightness.

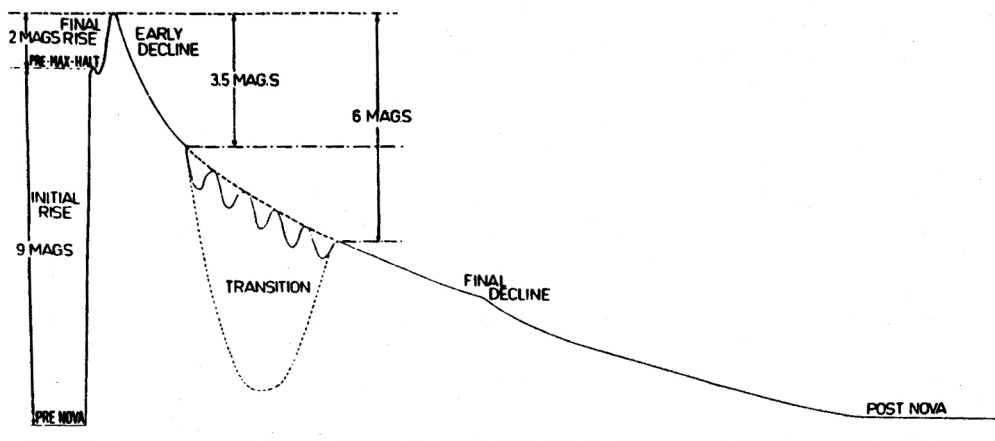


Figure 5. This illustration is from *Cataclysmic Variables*, Warner, 1995 and shows McLaughlin's compilation of mean nova light curves. Once luminosity has faded by ~3.5 magnitudes there are alternative paths in the decline: either a deep fade with a recovery to a normal light curve; or a period of pulsation-like variations; or no departure from the mean light curve.

Payne-Gaposhkin, 1954, put novae in five classes according to the speed of development as measured by the first two magnitudes of fading (t_2): very fast novae fade two magnitudes in 10 days or less, fast from 11-35 days, moderate 26-80 days, slow 81-150 days and very slow 151-250 days. On this basis HR Delphini was ultra slow!

Not all novae fit these classifications as we see in figures 1 and 3 above. Accepting that a majority of binary systems evolve through mass loss and transfer into CV systems it's little wonder that the fits are not good. But it all helps - the speed is usually related to the ejection velocity and other aspects are inter-related.

The strength of the 'explosion' determines the outward expansion speed of the ejected shell and also whether it's a fast, moderate or slow nova. Outward velocities of 500-2000 km/sec are normal. Since the stars in the system are usually separated by 500,000 to 2,000,000 kilometres the expanding shell will completely envelop the system in less than an hour or so. Even if the individual components were visible before the eruption they disappear from view once this happens.

Initially the expanding shell is dense and exhibits most of the properties of a normal star except for the high velocity. There is still some energy input from the white dwarf itself and more will be added with the decay of a range of elements produced in the original nuclear event. But basically the temperature of the shell will change in accordance with the relationship $L = R^2 \times T^4$, where L = luminosity, R = radius and T = temperature.

The brightness becomes smaller in a slowly flattening decline, although some novae show different behaviour once the brightness has declined by several magnitudes. There may be a sudden drop in brightness for a period with a later return to the normal declining light curve, others show a series of fluctuations almost like a pulsating star, during a similar interval. But by four magnitudes or so below maximum the normal decline curve recurs, although the rate of decline varies greatly between different novae.

Spectral features

Initially the spectrum is relatively featureless but as the density of the shell becomes less - inversely proportional to R^2 - it begins to develop emission features, most noticeably hydrogen alpha at 6563, H beta at 4861 and the Balmer series in the U filter; later a whole range of mainly emission features as it enters what is historically called the 'nebular' phase where the shell is closely similar to many of the classical nebular regions in our galaxy.

These make magnitude estimates through different filters difficult to understand. So initially we should observe as much as possible and resolve these later. At the start the most important electronic measures will be made using DSLR cameras and little is known about their performance with this type of object.

The post nova

As the shell dissipates the individual stars will once again be visible. If the inclination of the system is high it will be possible to derive a period of revolution of the binary system in one way or another. It is unlikely to show eclipses otherwise it would probably be already known as an EB. Accretion is unlikely to begin for some considerable time after the event - the mass-losing star will inevitably have been affected by the ejection of a shell and the intense radiation accompanying the initial stages of the outburst. The remnant will be near its pre-outburst magnitude, probably at about 12-13, so it's a big telescope project.

Novae in the cataclysmic variable cycle

There is a bewildering variety of objects in the CV field. Considering their origin this is not surprising. But it is believed that there is a cyclic pattern of some kind. There are phases when little appears to be happening, such as in the nova-like variables, or other times when mass transfer is clearly evident as in the widely different dwarf nova types.

It should be clearly understood that 'outbursts' of novae and dwarf novae are quite different. The first is roughly a thousand times brighter and involves nuclear fusion and ejection of material at substantial

velocities. In dwarf novae the outbursts arise from accretion heating of the white dwarf component, often with a variety of changes to the disc which is an intermediate step in the transfer of material from the secondary to the primary. But in strongly magnetic systems, as shown in Figure 4, a disc cannot form so accretion is directly onto the polar regions of the WD in a manner similar to the Earth's auroral regions.

Since the dwarf nova stage does not immediately precede the nova outburst - none of the novae shown here evolved from a known DN - there must also be a less obvious form of mass transfer to push the envelope of the WD into the regions where hydrogen become hot enough to burn. It's a disappointment that one of my favourite CVs, V803 Centauri, a pair of helium WD stars, will never become a nova as helium needs about 10^8K to ignite in this manner.

So we must realise that the driving force for all CVs, including novae, is the transfer of material from an almost normal star in contact with its Roche lobe to an accreting WD star. In the non-nova state energy is released as the gravitational or angular momentum is converted into heat - to some extent on a disc around the WD star, but mainly by frictional or collisional processes at the surface of the white dwarf. In the nova state, high temperatures allow nuclear fusion - a much more efficient producer of energy.

Ideas about mass transfer are often confusing. VW Hydri, the most well-studied member of the SU Ursae Majoris subgroup, has both short and long outbursts. At Auckland Observatory in the 1970s we determined that the long outbursts, or superoutbursts, were triggered by a normal outburst and involved continuing mass transfer for a period of 10-12 days. A cursory examination of the more conventional SS Cygni stars suggest that this prolonged mass transfer occurs there as well. So do we conclude that the sharp ordinary outbursts of the SU UMa stars are abnormal? The model is that they are caused by a disc collapse with a sudden increase in accretion onto the WD star.

V 1369 Centauri

On to the present event in Centaurus. The nova is fading in a series of sawtooth-like brightness changes, with a slow rise and a sharp decline. Quite clearly Payne-Gaposchkin and McLaughlin present a simple picture that does not really do justice to what is happening. But what mechanism is driving something like V1369 Centauri?

It needs to produce about 100,000 times the luminosity of the quiescent star - so how is that produced? And in this case it gets frequent energy injections to create separate brightness peaks. Some models of other novae postulate multiple explosions, although this seems to require an unusually high accretion rate - perhaps thousands of times the normal rate, whatever that is. Almost all novae have developed from stars where accretion is not prominent as in a dwarf nova. But the answer may lie in the concept that the previously accreted material is asymmetric and if the initial nuclear burning is localised this may distort the hydrogen envelope with turbulence driving different parts of the envelope into the hot, degenerate regions to allow repeated fusion events.

Other spectacular events

In recent years some interesting discoveries have been made by visual observers keeping a watch on the less active objects. Nova-like variables may be a good field to study. Mike Linnolt in Hawaii discovered BW Sculptoris, a nova-like variable, at 9.6 instead of the normal 17th magnitude. The outburst lasted less than 100 days. V1369 with its slow fading is quite unlike this other star but it's also rather low amplitude.

Stephen Hovell found GR Orionis, an old nova, bright one night in February of this year. This was confirmed by Rod Stubbings. The light curve is similar to BW Sculptoris or even U Scorpii, a well known recurrent nova, but of far less amplitude. Are these stars undergoing a rare DN type outburst? They have tentatively been classed as WZ Sagittae stars - but that star has a rather differently shaped light curve initially.

Conclusion

Most novae are not known as variable stars until the outburst. A very few arise from stars with rec-

ognised novalike features (the NL variables) but most have shown no variations. So if accretion is taking place - and it's essential to the model describing the outburst as due to hydrogen being forced into the high temperature degenerate region of the white dwarf star - why are we not seeing this accretion? Quite clearly in the immediately pre-nova stage the accretion is steady and not accompanied by the disc collapses of the dwarf nova stars.

So let's move along to see what has been achieved in the eight or so weeks since Nova Centauri 2013 appeared so dramatically in our skies. And let's keep the measures coming! The field of cataclysmic variables is very interesting but complex - and in many of its aspects it is beyond the abilities of the amateur observer. But in this context I must compliment members like Jonathan Powles and Malcolm Locke who are making spectroscopic measures which a decade or so I would not have dreamt that an amateur could do.

Tom Richards and I have discussed this and - acknowledging that visual, DSLR and CCD data will appear on the International Database, and that spectroscopic measures by our members will appear on a similar database - we'd still like to see a summary of all of these on our own website. Many of our members would not know where to look for spectroscopic data - I certainly don't. Just like HR Delphini was a big event in the Auckland Astronomical Society's early ventures into variable star observing, so is Nova Centauri 2013 a big event in the rejuvenated Variable Stars South. It would be very useful to have a place where we could all look from time to time and see how this nova develops. And as a historical record it will be very important. So please contribute to this.

Nova Centauri 2013 - *Carl Knight & Jonathon Powles*

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Relationship between colour magnitudes, light curve and spectra over the first 30 days

Introduction

For those VSS members hardy enough to brave the 3am starts, the first 30 days of Nova Centauri 2013 (V1369 Cen) have provided some fascinating puzzles and insights. Apart from the sheer excitement of such a bright nova (it has remained a naked eye object for its first month at least) appearing in an iconic Southern constellation, it has also raised a few intriguing questions. Unusually, it has displayed semi-regular magnitude oscillations right from its initial maximum on 5 December, and these magnitude oscillations have been accompanied by some marked changes in photometric colour values. There has been much good discussion and sharing of data on the Variable Stars South Google Group on the topic of this star and its behaviour, that has drawn in CCD, DSLR and visual observers as well as amateur spectroscopists, and this article is an attempt to pull some of that discussion together.

First, a quick revision of the basics of classical novae. Like most types of cataclysmic variables, novae occur in binary systems in which a white dwarf (WD) star is in close orbit with a main sequence star that overflows its Roche lobe. As a result, matter from the companion star escapes and is drawn down onto the surface of the WD, where temperature and pressure gradually increase. Because of the density of the WD, in which the matter is electron-degenerate, the accreting matter flowing to the surface of the WD cannot expand as it is heated; thus temperatures eventually rise to in excess of 20 million degrees Kelvin. This is enough to trigger a thermonuclear runaway (TNR) reaction¹, creating a cataclysmic explosion on the surface of the WD, causing an enormous outpouring of energy at a range of wavelengths, and blasting into space much of the accreted material, mixed with some elements from within the WD itself (the "ejecta"). For observers, the effect of this explosion is an increase of brightness in the order of 10–12 magnitudes over a period that can be as short as 1–2 days. This is typically the point at which a nova is discovered and observations begin.

¹ Excellent discussions of the progenitors including hydrodynamics and reaction networks are found in Hellier (2001) and José (2012).

After the initial explosion and maximum, novae can exhibit a wide variety of behaviours: fast or slow decline; long- or short-period oscillations in the light curve; the formation of dust which for a period significantly dims the visual magnitude. However, there is an idealised set of phases through which most novae progress; these were drawn together by Cecilia Payne-Gaposchkin in her seminal monograph *The Galactic Novae* (1957), a source that still has relevance today.

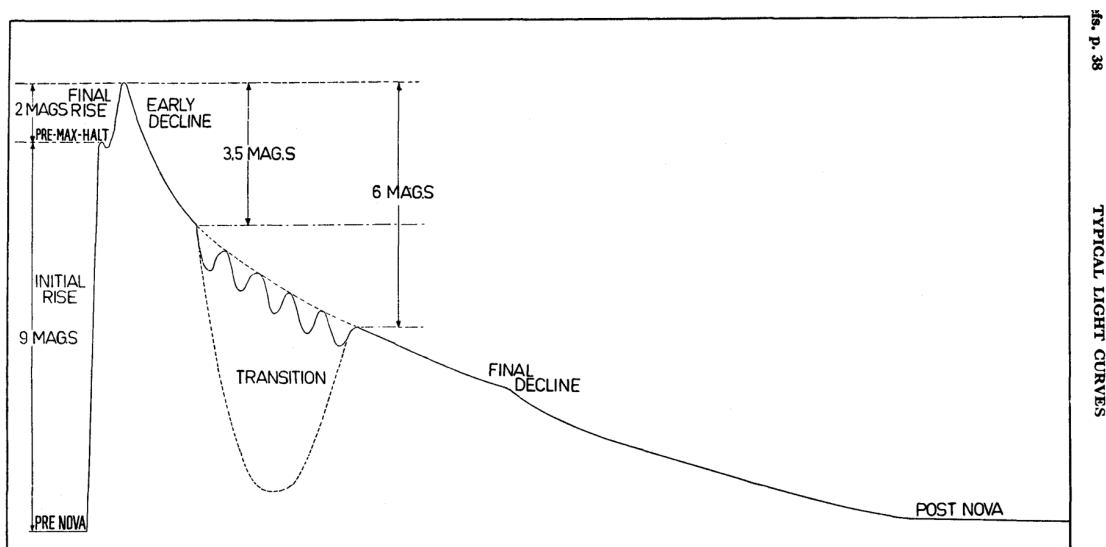


Fig. 1. 8. Schematic light curve of a nova, showing typical stages. The time scale is not uniform throughout; it has been magnified in the early stages. After McLaughlin.

Figure 1. The typical stages of a nova light-curve, Payne-Gaposchkin (1957)

V1369 Cen light curve

So how does this idealised curve compare with the V1369 Cen observations? These are given in Figure 2, for the first thirty days since maximum:

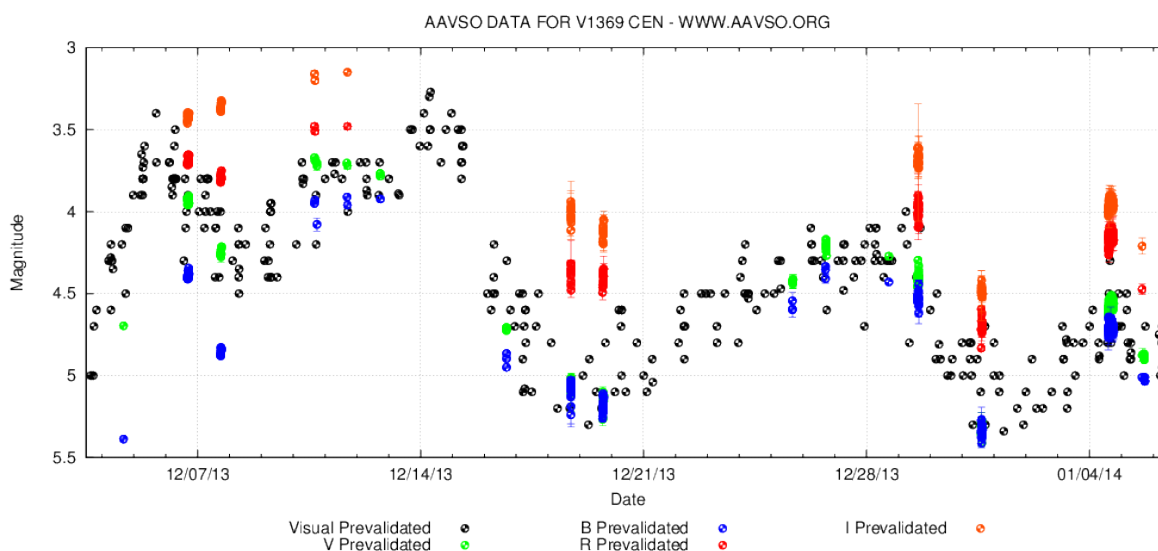


Figure 2. V1369 Cen Light Curve to 6 January 2014. AAVSO Light Curve Generator.

The light curve shows a number of peaks and dips over time, which is in itself slightly unusual. We are still in the phase marked “Early Decline” in figure 1. The oscillations have started right from initial maximum on 5 December, whereas in the majority of novae there is a period of smooth early decline after maximum before the oscillations set in (if they do at all). Only the slower novae tend to show oscillations from the outset (Warner, 2008). The observed oscillations in V1369 Cen are accompanied by marked variations in the B-V and V-R colour measurements, and in the spectra, as will be discussed in the next section.

The maxima and minima of these oscillations, together with the photometric and spectral data acquired, are listed below:

Date	Event	Visual magnitude	Data acquired
5–6 December	Maximum 1	3.5	BVRI, spectra (6/12)
8 December	Minimum 1	4.2	BVRI, spectra (7/12)
14 December	Maximum 2	3.3	none; BVRI and spectra from 11–12/12
18 December	Minimum 2	5.2	BVRI, spectra
29 December	Maximum 3	4.0	none - BV, and spectra from 25–26/12
1 January	Minimum 3	5.3	None
4 January	Maximum 4	4.3	None
6 January	Minimum 4	4.9	BV, and spectra 5–6/1

Table 1. Details of maxima and minima.

It is not clear, to us or from the literature, what actually causes these oscillations in magnitude. There are a number of possibilities, but it would be beyond the scope of this initial discussion to speculate.

However, to understand what is happening, it is important to realise that, despite variations in the visual curve, the total bolometric luminosity of any nova remains roughly constant (Warner 2008)². This only became evident once space-based instruments were available to measure wavelengths unable to penetrate earth’s atmosphere. As an example, in the initial decline, the visual luminosity decreases rapidly as the initial fireball expands and thins. This allows more of the UV and higher-frequency radiation from the WD itself to penetrate the expanding ejecta. Visual magnitudes become fainter but the UV increases commensurately; such that total radiation remains the same.

A second example occurs when, as is often the case, dust ejected by the nova forms a visually opaque shell during the transition phase of the light curve. Here, dust absorbs the visual wavelengths, causing the drop in magnitude; but as a consequence the dust heats, causing a commensurate increase in IR radiation.

Understanding the “swings and roundabouts” nature of the total emission is important in interpreting the data to follow.

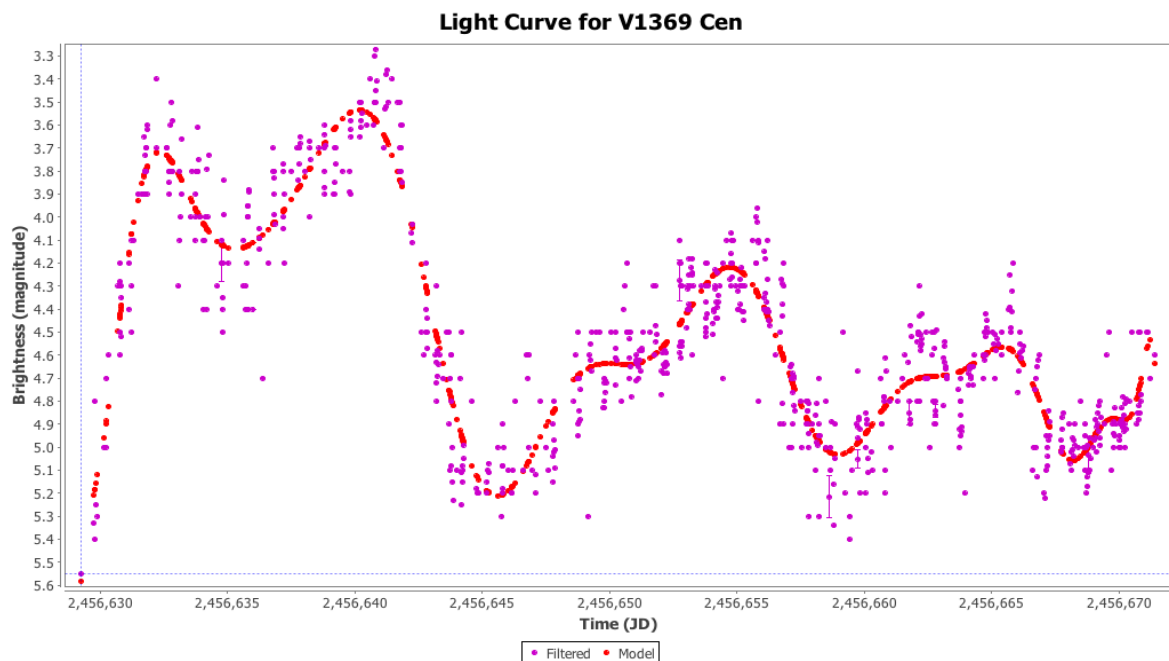


Figure 3. Polynomial fit to the V1369 Cen light curve — Jonathan Powles/David Benn.

² The term “bolometric” here refers to the total emissions across all wavelengths of radiation.

A polynomial fit to the V1369 Cen light curve (figure 3) also makes something clear that by itself the light curve does not. Beyond the first two maxima, there has been something of a stalling of the increase in magnitude prior to each subsequent maximum. It is tempting to also suggest that the minimum between the first two maxima is the same feature under different and earlier conditions than the latter events.

Colour magnitudes

There are observable correlations between colour magnitudes, the light curve, and the spectra of V1369 Cen over the first thirty days of the nova.

Colour filter observations can be seen in the light curve in Figure 2. The relevant colours are the Johnson photometric standard wavelengths where $B = 4450\text{\AA}$, $V = 5510\text{\AA}$, $R = 6580\text{\AA}$ and $I = 8060\text{\AA}$ (Wikipedia 2013b). Relative to what we can see, B is blue, V is “visual”, actually greenish in appearance, R is red and I is near-infrared and not visible at all.

Figure 4 shows the colour relationships that can be established from the B, V, R and I band measurements made of V1369 Cen from detection up until January 6th (AAVSO International Database). Each point in the graph in figure 4 is telling us something about the relative strength of different colours (Johnson standard filter bands) of light and over time how those relationships are evolving.

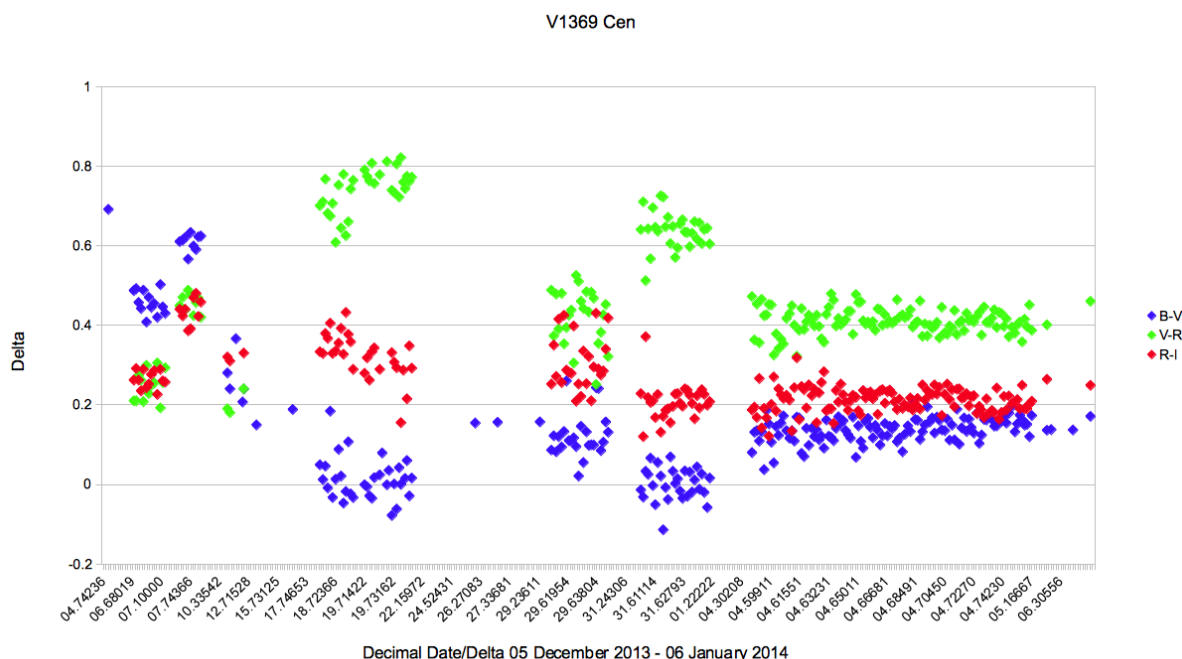


Figure 4. V1369 Cen colour relationships to 6 January³.

Fundamentally, the smaller the difference in B-V, V-R or R-I (including negative values) the more the left-hand band in the subtraction is contributing (relatively) and the less the right-hand band in the subtraction is contributing. For example if $B = 3.54$ and $V = 3.68$, then $B - V = -0.14$ which means that B magnitude is contributing more relative to V magnitude; ie 3.54 is brighter than 3.68.

How those relationships are changing over time is where the real information lies. All the information is in the normal light curve (figure 2), but examining B-V, V-R and R-I makes some of those changes much more obvious.

Spectra

The spectra in the next figures are graphs showing wavelengths (x) against relative intensity (y). A dip in the line shows absorption, a peak in the line shows emission.

³ In figure 4, the x axis is decimal dates ordered by data point and not evenly distributed over time. This is to allow the spread of data to be easily seen.

As an introduction to how the spectral graphs work, figure 5 shows the nova spectrum from 19 December 2013 in comparison to some standard stars. The relatively hot Fomalhaut (A3V - 8,500K) and cooler Antares (M1.5Iab - 3,500K) each show an approximation of a black body continuum with some absorption features⁴. In the case of Fomalhaut the slope is from left (the blue end of the spectrum) to right (the red end) — showing a hot blue continuum with absorption lines corresponding to the Balmer series (H α at 6563Å, H β at 4861Å, etc. (Wikipedia 2013a)). The Antares spectrum shows a slope in the opposite direction — showing a cooler star, dominated by broader molecular absorption features, principally TiO.

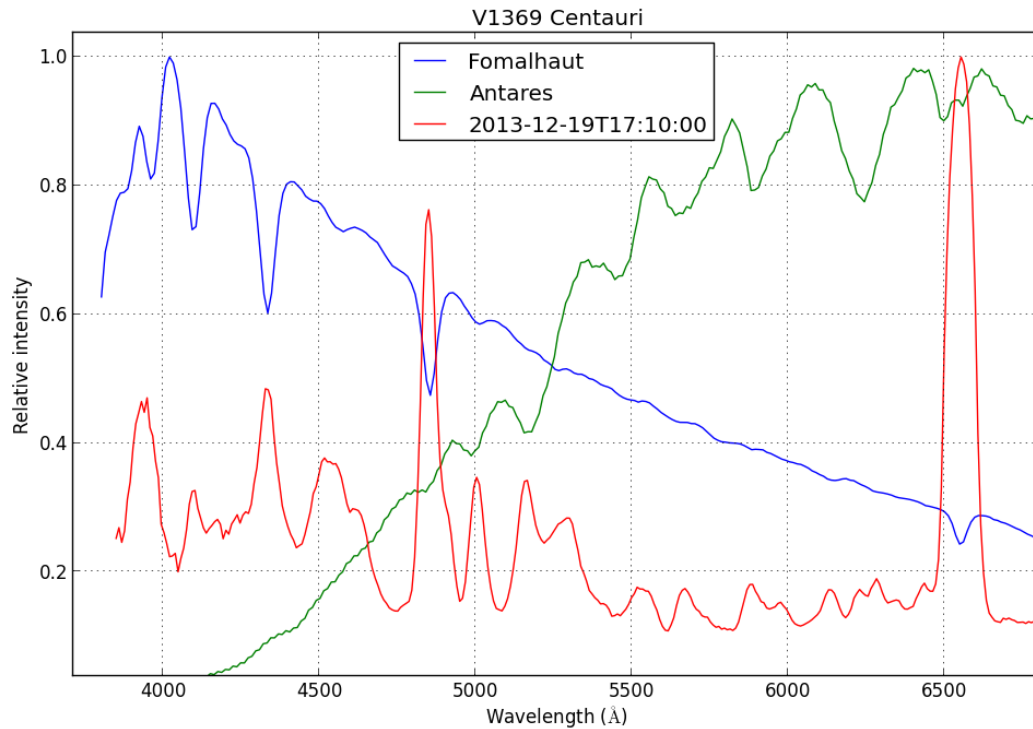


Figure 5. *V1369 Cen spectrum alongside similar resolution spectra of Fomalhaut and Antares.*⁵ *V1369 Cen spectrum — Jonathan Powles. Fomalhaut and Antares spectra — Malcolm Locke.*

In comparison to these, the nova spectrum of 19 December shows an underlying high temperature continuum (more like Fomalhaut), but with a major emission contribution from H α , and H β .

While we are considering the overall nature of spectra, it is useful to look at precisely how the spectral features we will be considering line up against the filter response curves used for the photometry. This is shown in figure 6.

⁴ Dips in the intensity owing to the absorption of light by elements in the cooler stellar photosphere.

⁵ Each of these spectra have been scaled to unity, so that the maximum recorded Y (flux) value is 1. Therefore the flux values of each spectrum are not to scale, and can only be used for a qualitative comparison with the others.

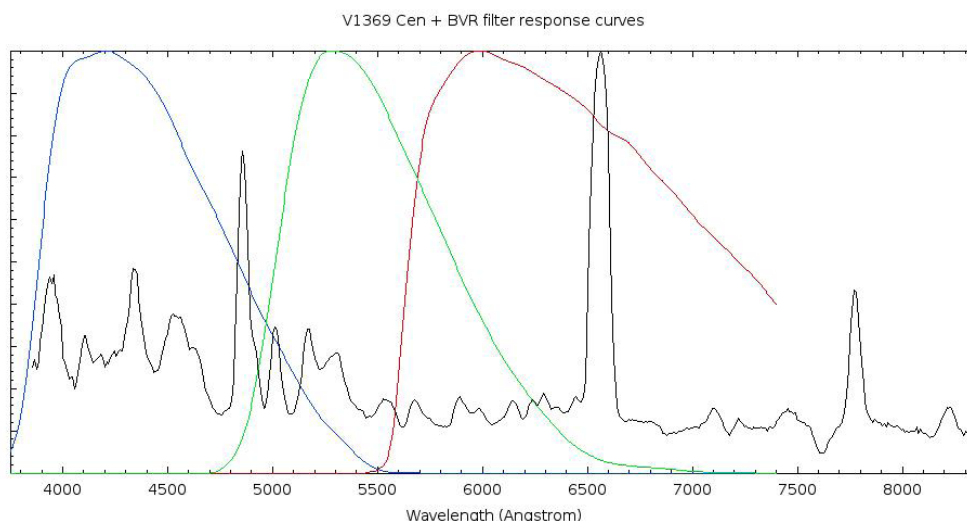


Figure 6. V1369 Cen spectrum overlaid with BVR filter response curves — Malcolm Locke.

How do the spectroscopic observations compare with the colour photometry and light curve we saw earlier? Figure 7 gives a set of low-resolution spectra taken of V1369 Cen between 6 December 2013 and 6 January 2014.

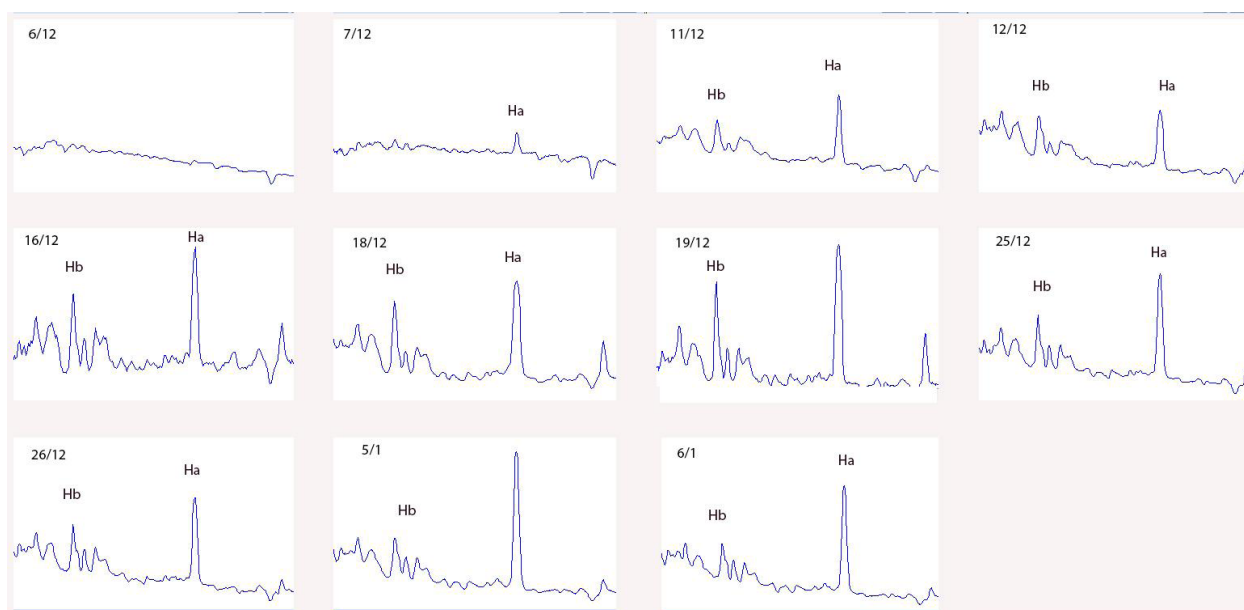


Figure 7. Spectra of V1369 Cen 6 December 2013 to 6 January 2014 — Jonathan Powles.

Of particular interest is the development of strong emission lines — H α and H β , and the cluster of FeII (singly ionised iron) lines around H β . Over the course of the 30 days, the overall picture is one of the emission lines growing steadily brighter. This is exactly what we expect — the dense fireball ejecta of the initial explosion hurtles outwards and more than 1000 km/s, gradually thinning and becoming more like an expanding emission nebula.

There are more detailed features visible in these spectra, but to interpret them we need to relate the dates of development of particular line features back to the dates on the light curve (figure 2) and the graph of colour relationships (figure 4). Once we have done this we can begin to explain some of the visible changes in the light curve and the colour relationships driven by spectral changes over time.

Relating the spectral, light curve and colour magnitude data

The first maximum occurs around 5/6 December and the corresponding visual magnitude found in figure 2 was around 3.5. The first BSM South data (AAVSO International Database) on 6 December shows that the B, V, R and I magnitudes are closely spaced. B-V is greater than V-R and R-I. In fact, initially V-R and R-I are essentially the same, (0.2), while B-V is larger (0.5). At this time the spectrum is fairly flat; we are just seeing the fireball ejecta, still too dense and opaque to display emission and absorption lines.

In the next block of BSM South data on 7/8 December, B, V, R and I have begun to spread markedly. Interestingly the I magnitude has increased, the R magnitude has decreased very little, but the B and V magnitudes have decreased noticeably. The spectrum corresponding to these dates shows very little if any H β emission at 4861Å but does show signs of H α emission at 6563Å as the hydrogen in the outer layers of the ejecta (and possibly in the stellar wind surrounding the binary pair) become ionised by the energy of the explosion (see eg Shore, 2012, for a description of the ionisation process and Williams, 2012 for the stellar wind interpretation). Correspondingly B and V magnitudes are less than R and I, as the red emission line at 6563Å begins to develop and contribute more to the overall visible flux.

Given that the spectra show little or no H β at this point, what is the source of B and V? Presumably these are simply being provided by the continuum of the nova ejecta fireball. The ejecta are still far too dense to see the emissions from the WD itself. Nova specialist Professor Steve Shore calls this the “Iron Curtain” phase of the nova, owing to the signature chemical composition of these opaque ejecta (Shore, 2012).

The light curve dipped and achieved its first minimum on 8 December. Then the light curve begins to brighten again, at least visually and in B, V and R. It then reaches a second maximum around 14/15 December that is marginally brighter than the first, at around magnitude 3.3. What has caused this brightening in the visible wavelengths? Looking at figures 2 & 4 it can be seen that B and V have staged something of a comeback. The contribution of B and V to the light curve has caused an overall brightening. R has also increased while I has peaked. Examining the spectra on the dates in question we can see that relative to the continuum, H α and H β are now showing strong emission. It is most likely that H β (4861Å) being effectively cyan has caused B (4450Å) and possibly V (5510Å) to brighten. This can be seen in figure 4 in that B-V is smaller as is V-R while R-I is largely unchanged. The increase in R is most likely the result of the increase in H α emission.

Our next minimum occurs around the dates of 18–20 December in figure 2. Here something interesting occurs. B-V is at times negative (figure 4) indicating B > V (remember the smaller number means brighter magnitude, hence 3.0 > 4.0). The corresponding spectra seems to show still increasing H β emission (figure 7). Clearly the B magnitude is more greatly affected by the amount of H β emission than the V magnitude. Around 19 December the H α seems to be at its strongest relative to the continuum. R and I magnitudes have not dipped anywhere near the amount that B and V magnitudes did for this minimum. While the R-I values for the dates in question (figure 4) show more spread, a mental trend line drawn through those points suggests the R-I have remained largely unchanged from what they were at the maximum of 14/15 December.

From the minimum of 18–20 December we rise more gradually toward the maximum of around 29 December. In this maximum R-I covers a similar range (average 0.22) as it did at the minimum of 18/19 December (average 0.26). The similarity is most clearly seen in figure 4. The H α and H β relative to the continuum⁶ are also on the wane so what is driving this increase in B and V (figure 2) in particular in this maximum? The absence of data leads to speculation. The continuum is of course broadband and it may simply be the source of the increase. It is also possible that something more opaque to B and V has now thinned and we are seeing more B and V from deeper in the ejecta. Interestingly, and germane to deciding which, at this point both B-V and V-R suggest that V itself has strengthened relative to both B and R. More multi-wavelength observations are needed to resolve these issues.

Looking at figure 7, we can see that around 11-12 December and 25-26 December, close to the maxima

⁶ We must be cautious here as the continuum may equally be on the rise. Most of the spectra are not calibrated in absolute flux so we cannot concretely say whether H α and H β are waning, or the continuum is waxing.

of the rebrightenings, the spectra have a stronger slope upwards to the left (blue). This matches the observed smaller B-V values, which are therefore coming from the shape of the continuum (the fireball and WD itself) rather than the emission lines from the rarefied ejecta.

The third minimum for the period we are examining occurs around 1 January. Figure 4 data for 31 December shows B-V has gone from around 0.1 to 0 and R-I indicates that R has strengthened compared to I. In combination these relationships seem to suggest that some weakening of V and strengthening of R relative to V has yielded the significant change in V-R from slightly more than 0.3 to around 0.6. Looking at the spectra over the period in question there appears to be continued weakening of H β whilst H α is resurgent peaking later around 5 January in figure 7. It seems safe to say that the increase in R is well explained by the resurgent H α .

We then come to the final rise of the period in question. This peaked around 4 January as seen in table 1 and figure 2. B-V has increased and V-R has decreased indicating that V has strengthened again, similar to the maximum of 29 December. It would seem that these maxima might be more strongly associated with the increase in V than other bands. The R-I relationship remains largely unchanged through this maximum.

The last maximum is followed by the final minimum on 6 January. We have little in the way of photometric measures for this minimum. Spectra in figure 7 shows diminished H α emission. The only B-V data suggests that there is now more V relative to B. V-R and R-I appear essentially unchanged.

Conclusion

More accurately this is the “lack of conclusion” section. As stated in the introduction this article is a record of discussion in the VSS Google Group. We have expanded on much of what was discussed and made some observations. We have speculated in places but not concretely argued one way or the other. It is still early days and data is still arriving for the period we have examined. This has led to the light curve and the colour relationship graphs in particular suffering no fewer than four revisions.

In “conclusion” we look forward to where the efforts of all involved in the collection and analysis of whatever proves to be the final data set for V1369 Cen might lead

About the authors

Carl Knight (CK).

By profession Carl is a software engineer. He observes from the rural Rangitikei, New Zealand. His variable star interests lean towards late stellar evolution, particularly anything that goes “bang”. He hopes eventually to be able to provide BVRIJ and H photometry, and spectroscopy on demand. And to provide an education resource via his observatory to local secondary schools.

Jonathan Powles (JP).

Jonathan is an academic in the fields of music and education, originally from Sydney but now director of the Teaching and Learning Centre at the University of Canberra. He bought his first telescope as a teenager in 1986 “to look at Halley’s comet” but found almost everything else in the sky infinitely more fascinating.

Equipment used

CK. Pentax K10D DSLR piggy-backed on a Meade 12” SCT for photometry. Binoculars for visual observations of the nova.

JP. Meade 10” SCT on a Losmandy G11; Star Analyser 100 spectrograph, Atik 383L+ camera. Photometry on Nova Cen has been to date through 80mm Orion Short tube guide scope.

Thanks

The authors are indebted to David Benn and Malcolm Locke in particular. David and Malcolm have reviewed the article from its inception to the finished product. They have provided excellent guidance and caution.

We also need to thank everyone that has given us permission to use spectra or data. We acknowledge with thanks the variable star observations from the *AAVSO International Database* contributed by observers worldwide and used in this article.

And thanks also to all the VSS members and Arne Henden of the AAVSO for participating in one of the most enlightening and active discussions seen in the VSS Google Group.

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BL Tel – please explain yourself! – Col Bembrick

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Introduction

In the VSS Newsletter of 2011/4 the following statement was included in the conclusions of my article “BL Tel Revisited”...

“It is worth noting that the quoted error for the period is now 0.02%. Thus the mid-point of the next primary eclipse of BL Tel is predicted to occur on HJD 2456478.83 +/- 0.52. This equates to 5th July, 2013”.

So, what transpired at the 2013 primary eclipse of BL Tel?... My prediction was blown out of the water!

Some background

A brief literature survey is summarised again here to highlight some interesting features of this long period eclipsing system. The primary is an early F-type supergiant with T_{eff} of 6700K (Sasselov, 1984), while the secondary is probably a cool supergiant, filling its Roche lobe to the inner Lagrangian point. The T_{eff} of the secondary is <3100K (Feast, 1967). The secondary has been and is still losing mass – implying a possible period change. Neither primary nor secondary star is spherical and the orbits of the system are elliptical ($e = 0.31$), with primary eclipse occurring at periastron (Feast, 1967), when the two stars have a separation of 3.43 AU. The primary star shows semi-regular, non-radial pulsations (a few tenths of a magnitude) and mode switching, with $P_1 = 65$ days and $P_2 = 73$ days (Sasselov, 1984). The orbital inclination, $i = 90^\circ$, and relative radii, $R_2 = 0.84R_1$ with masses $M_1 = 20$ solar, $M_2 = 7$ solar (Feast, 1967).

In 2011 the maximum time of totality was estimated from the CCD data at 7.3 days – cf 5.2 days in 2000 (Bembrick & Ainsworth, 2011). Much of this difference is most probably due to incomplete data, but some could be due to the pulsations of the supergiant primary – as mentioned above.

Picking the ToM in 2013

As recorded by the AAVSO database of observations, many observers gathered data for the 2013 primary eclipse of BL Tel – visual, CCD, DSLR and PEP. These results can best be summarised by the light curves below – taken from the AAVSO database.

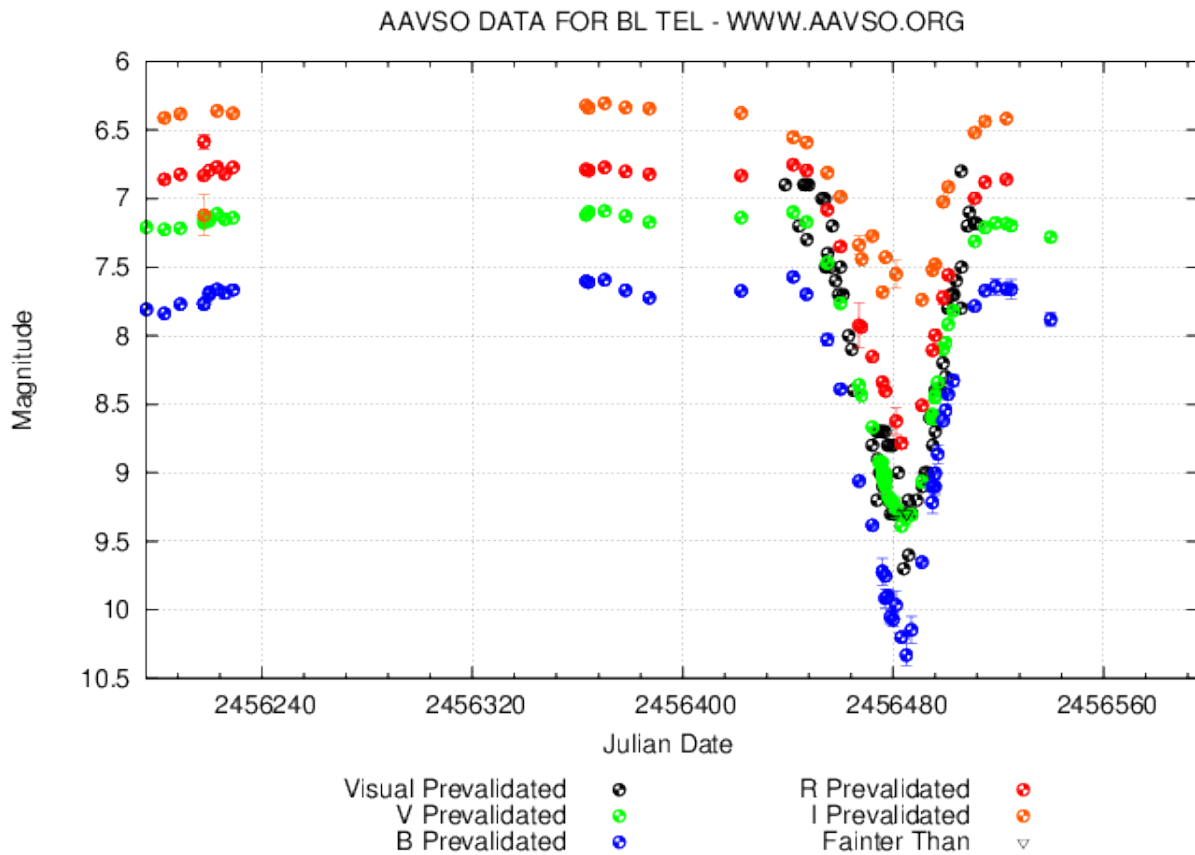


Figure 1. Multiwavelength light curves for BL Tel primary eclipse in 2013.

Extracting just the V and B band light curves makes the picture a little clearer...

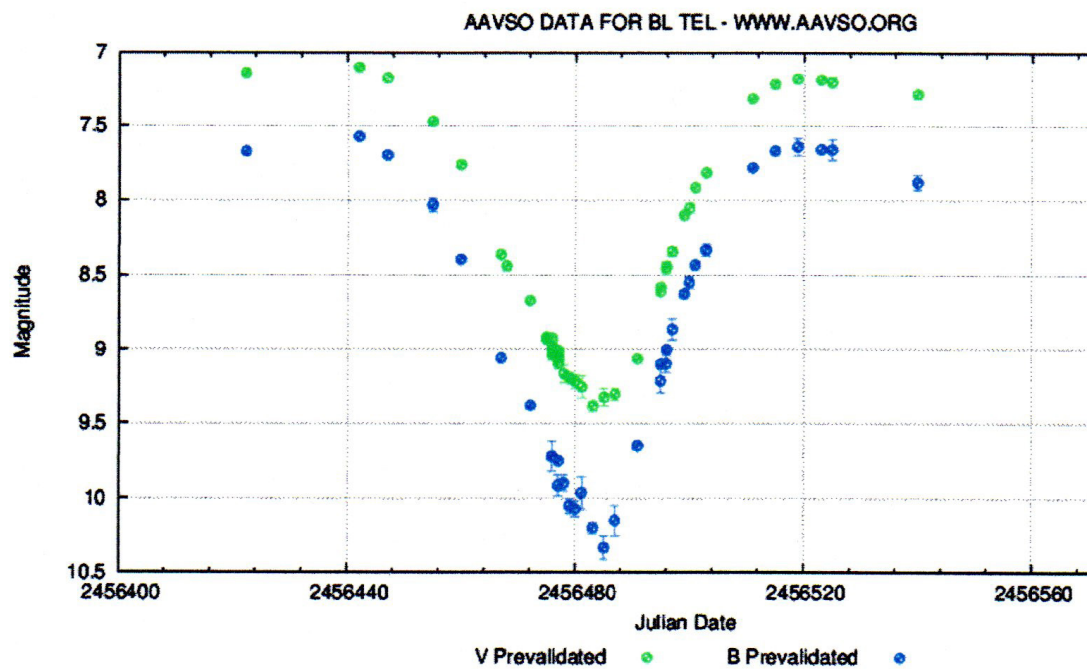


Figure 2. V and B band light curves for primary eclipse of 2013.

In 2013 the V band data seems to allow a primary total eclipse period of some 5.3 days (cf 5.2 in the year 2000) – although the data are sparse here. In contrast, the B band data, with deeper primary eclipse, appear not to support a period of totality.

Using the above V band data and the polynomial fitting routine in Peranso, multiple trials with different orders and cursor positions yield a value of HJD 2456484.44768 $\pm$ 0.35 for the primary minimum.

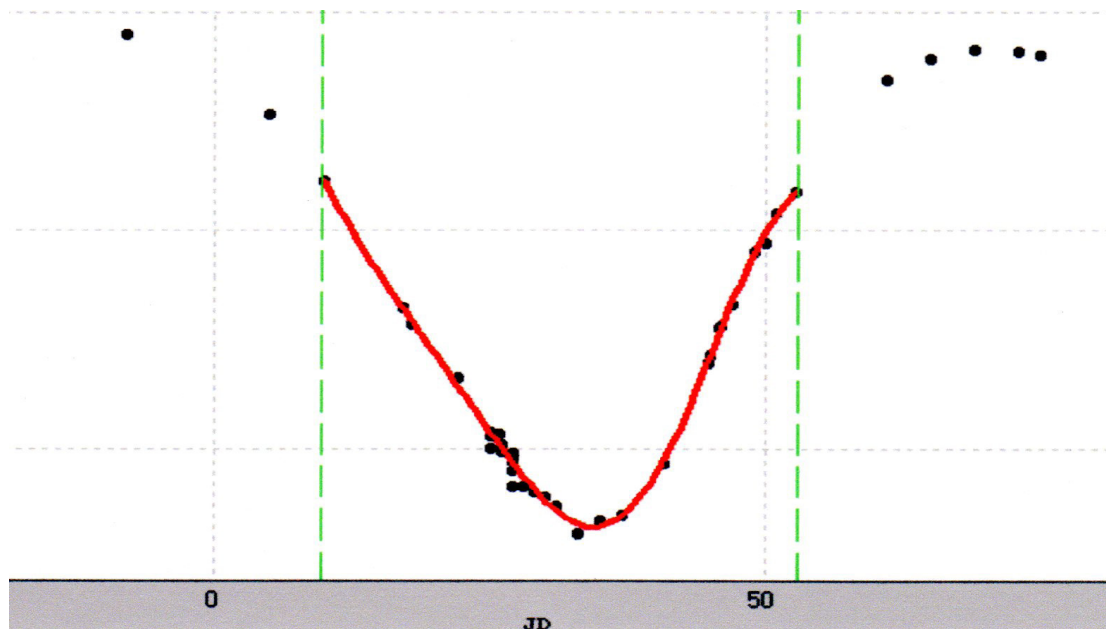


Figure 3. The polynomial fit to the 2013 data using Peranso.

Note the distinct asymmetry in this light curve – this has been reported in the past - both in CCD light curves (Bembrick & Ainsworth, 2011) and in the visual data. The asymmetry has been attributed in the literature (van Genderen, 1983) to small amplitude (0.15mag) pulsations present in the A component of the system over a 65 day period. The phase of this pulsation relative to the primary minimum is said to produce the observed asymmetry.

In this respect, it can be seen that if the above curve was made symmetric it would yield a ToM of smaller JD, closer to the predicted (Bembrick, 2011) value of 2456478.83.

The above estimate of the ToM for 2013 has been added to the table of Bembrick (2011) to illustrate the marked difference in the O-C for 2013 – see Table 1.

Table 1. O-C values using epoch of 2011 and a Period = 777.675 days.

Cycle No	Observed (HJD 24....)	Calculated (24...)	O-C (days)	Year
1	43258.5	43258.36	0.14	1977
4	45591.5	45591.38	0.12	1983
5	46369.5	46369.06	0.44	1985
6	47144.5	47146.73	-2.23	1987
8	48703.0	48702.08	0.92	1992
9	49481.0	49479.76	1.24	1994
10	50256.0	50257.43	-1.43	1996
11	51034.5	51035.11	-0.61	1998
12	51813.21	51812.78	0.43	2000
17	55701.16	55701.16	Epoch	2011
18	56484.447	56478.83	5.61	2013

NB: In the above table observed ToM have been transposed to HJD although the heliocentric correction is small for this high ecliptic latitude system.

Discussion

How are we to explain this departure from prediction in 2013? A major period shift of more than 5 days over one cycle would (presumably) have to involve a catastrophic mass transfer event to bring this about. This would appear to be astrophysically unlikely. If an event of this type had occurred then it would most likely have produced some sort of flare behaviour, which would have been observed and reported. I've seen no alert notices over the last few years that would indicate this had occurred.

Looking at the light curve of figure 3 it would seem that the asymmetry may be the culprit. Asymmetry in the light curve at primary eclipse has previously been attributed to the effects of non-radial pulsations of the primary star, with two periods being identified – 65 and 73 days. If these two periods were to “beat” together at primary eclipse then this may possibly account for the asymmetry of the light curve and the large shift of primary minimum. This is my current speculation – someone with more astrophysical background than myself may have more plausible interpretations.

It has been postulated in the literature (van Genderen, 1983) that there may be some modulation of the pulsations by the orbital period, due to the eccentric orbit. Calls have been made previously (van Genderen, 1986) for detailed photometry both immediately before and after primary eclipse. This would enable the determination of the phase of the pulsations relative to the primary eclipse. It would seem that to accurately predict the time of minimum we need to model the pulsation period(s).

As I said in 2011 “This is clearly a very interesting binary system, about which we have much to learn, and further study is certainly warranted”.

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What to do on a cloudy night? – Stephen Hovell

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In the Far North of New Zealand, we have been getting more than our share of cloudy nights through August, September and October. November was much better up to 24th. As I write we have had 15 cloudy or rainy nights in a row. Frustrating! Here's what I have been doing.

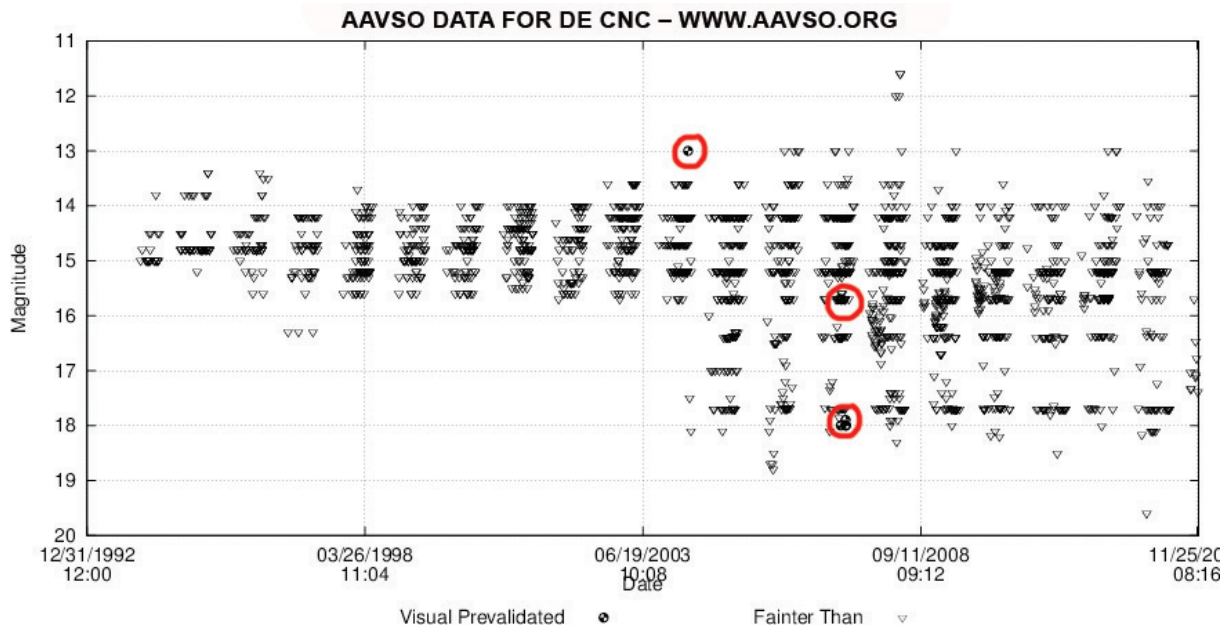
I observe CVs, RCBs, NLs and similar using my Meade 12" LX200. My limiting magnitude on a really good night is about 15.3. A number of these stars do not have a visual magnitude range, just a photographic range. But even for those with a visual range, this is not always reflected in the spread of visual observations recorded in the AAVSO database. So I have been trawling through light curves (using the Light Curve Generator – LCG) checking on the ranges of the stars I observe.

Perhaps the main reason for doing this is that it is pointless for me to observe a star with a photographic range of say 135p-180p if it never gets brighter than 15.5V. And I have found several interesting things.

I highlighted four stars for discussion through the CV Forum (go to *AAVSO Forums* <http://www.aavso.org/forum>) then scroll down to *Variable Stars* and then down to *Cataclysmic Variables* (CVs): DE CNC, V650 ORI, QZ LIB, and V499 ARA.

DE Cancri

This star was classified as a UG with a range 146–180p. Its 2000 coordinates are given in the Variable Star Index (VSX) as 08h 35m 27s +19° 45' 31" and it is one star that I observe from time to time. Being so far north from my place, the observing season is limited.



AAVSO Visual observations of DE CNC

Since 1 January 1993 there have been 2010 **visual observations**, BUT only six positive sightings (circled above in red). Four were around 18.0 which is supposed to be the minimum for this star. One was at 15.7, and was made by an experienced observer. I note that on the night before and the night after, the variable was recorded at <15.7 by this same observer, and I suspected it should have been recorded at <15.7 as well. One observation was made at 13.0, again by an experienced observer BUT no chart nor comparison stars were given and it was the only observation of this star by that observer. There is a 13.0 in the field and I wonder if this was mistaken for the variable.

I note that there have been 853 **CCD observations**, many of them positive at around 17.0–19.0 with some as bright as 16.3.

So I asked the question: “What has happened to DE CNC?” If this were a UG, we should have seen outbursts as the coverage was mag 14–16 for the first ten years, and 14–18 for the second ten years. I also posed the question, “Could DE Cnc be a UGWZ?” as that might explain the lack of outbursts.

Here’s what I found out.

There are two references to the star in VSX, both in German. Two were by W. Goetz, Sonnenberg. *A New Variable Star (=S10803)*. Mati Morel provided a translation of the first paper. The object was discovered on 21 February 1977 at mag 15.8. It was noted that the star appeared on several Palomar plates only when at maximum. A finder chart was published with comparison stars.

Several people contributed to the discussion. Patrick Schmeer posted some most interesting information.

“Here is an excerpt from a private message that I wrote to Dr. Peter Kroll on 2005 January 26: “According to GUIDE 7.0 on 1977 Feb. 21 at 20h23m UT (588) Achilles was only 28” due south of the above-given catalogued position of DE Cnc. The minor planet was at mag 15.2 and moving at 17”/h due west (PA 271 deg). Since W Goetz did not mention both the outbursting object and nearby (588) Achilles I would consider this (main) outburst non-existent (the plate has to be checked - the time of observation, too). For the other dates I could not find any minor planets sufficiently close to DE Cnc. Maybe some of the other brightenings were too close to the limiting magnitude? Or the variable was misidentified?”

Summary: Maybe there is a variable star at the position of DE Cnc, but in my opinion at least the main outburst did not occur. The other reported brightenings have to be checked.”

Patrick followed up with this comment:

"In February 2005 Dr Gerold Richter and Dr Wolfgang Wenzel confirmed after checking the Sonneberg plates that the object "in outburst" on 1977 February 21 was indeed (588) Achilles."

Patrick made the adjustment in VSX and this once classified UG turns out to be an asteroid.

So from now on, I won't be observing DE CNC. Hopefully neither will you.

V650 Orionis

V650 Ori has a photographic range of 15.5p–<17.5p. I observed this in the hope that it might rise to the mid 14s. Mike Linnolt (Hawaii) said,

"It's usually in the mid-16s but once I saw it brighter at 15.7, but I've only followed it a couple of years. A pretty tough positive estimate even in my 20" under dark skies!"

Gary Poyner (UK) said,

"I've seen it a few times in the low 15s and 16th mag, but usually I make negative observations. It's one of those fields which is difficult for a visual observer for some reason. I also have some time series data obtained by Ian Miller showing V650 Ori rise from 15.65C-15.25C over the course of 30 minutes or so. This data has been analysed by Chris Lloyd and he suggests that the flickering analysis points to a possible UX UMA type object (similar to IX Vel), but that was from just one short run so a lot more work needs to be done... There are suggestions in the literature that V650 Ori does brighten."

"V650 Ori has been on the BAA Recurrent Objects Programme for some years now, and I intend to keep it on until we can establish it's true ID and hopefully it's type. It needs a higher profile for that to happen of course, and obviously far better attention from CCD observers who can carry out a more intense and accurate monitoring programme than us visual types. As a visual observer I won't be dropping it from my programme though - just in case something unexpected does happen!"

So I will cross this one off my list until I get my big telescope.

QZ Librae

This star is classified as a UGSU with a range 11.2 - 18V, perfect for my telescope. But, only one outburst has been seen back in April 2004. It has been observed fairly extensively since then and no-one has picked up any positive visual sightings. I asked myself why, and so posed the question on the forum, "Could this be a UGWZ?"

Both Mike Linnolt and Sebastian Otero confirmed its UGWZ status. Sebastian remarked: "Yes, it seems it was known to be a UGWZ from *vsnet* observations and it has been classified as such in several papers by Kato et al., including this one: <http://adsabs.harvard.edu/abs/2009PASJ...61S.395K>

I have updated the VSX entry.

So now we have it listed as such in VSX and on our charts.

V499 Arae

The range is 14.8–<16.2p. There have been 439 observations since we first started observing around 1998. Most negative observations are between 15.0–15.5 and need I say that 91% of all observations are by Rod Stubbings. There have been 42 positive visual observations ranging from 17.2–18.3 in 2004–06 but nothing in the nature of an outburst typically associated with a UG. You would think at least some outbursts would have been recorded during this time frame. So once again, I asked if anyone could shed light on this star.

Mati Morel advised:

"This object is classified as a DN, or even DN SU, but verification is very thin. One outburst was observed on JD 2436781 = 1959 July 31, by Hoffmeister (1963). His remark, that only one maximum was observed, is repeated by Khruzina and Shugarov (1991) in their atlas (Atlas of Cataclysmic Variable Stars

of type U Geminorum). [There is] no spectroscopic confirmation. V499 Ara was on the target list of FUSE (Far Ultra Violet Spectroscopic Explorer) with the result either negative, or inconclusive. They make the remark: "No evidence of a (far-UV) source in any channel". Visit http://archive.stsci/prepds/fuse_cv/. Most of the spectral trace is just noise (I think).

When I asked Mati if the star actually existed, he replied, "There appears to be no doubt as to the identity of Hoffmeister's star."

"USNO-B1.0 and USNO-A2.0 both yield a visual mag. of 17.7 for the star (the same star as listed in VSX). But, it seems that it doesn't have the right spectral signature for a UG star. The range being about 3.0 mag., yet regular outbursts are lacking. A conundrum indeed. I suppose it becomes an individual decision, as to whether you give other targets a higher priority, yet with your particular instrument you are more capable of keeping an eye on it. Depends on whether you feel happy following a do-nothing star."

I did remark to Mati that I had been watching GR ORI for several years with nothing happening. In fact, nothing had happened since 1916, the last recorded outburst! And then in February/March 2013, suddenly, it was there. It turned out to be a UGWZ. You never know. I'll observe V499 ARA when I get a bigger telescope.

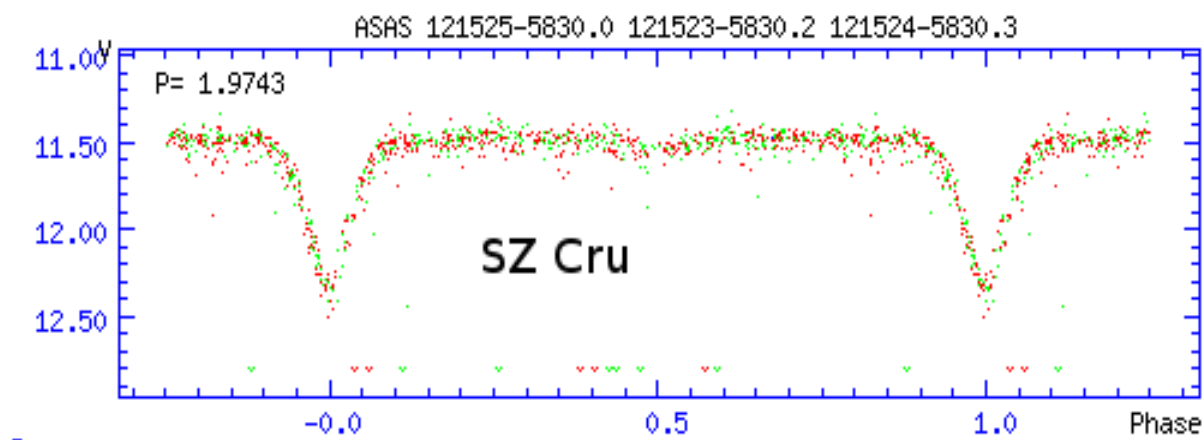
All this came about from looking at light curves. Of course, I would rather be outside observing, but there is usually something to do when it's cloudy or raining (even if it just vacuum cleaning!)

Southern eclipsing binaries programmes - *leader Tom Richards*

tom.richards@variablestarssouth.org

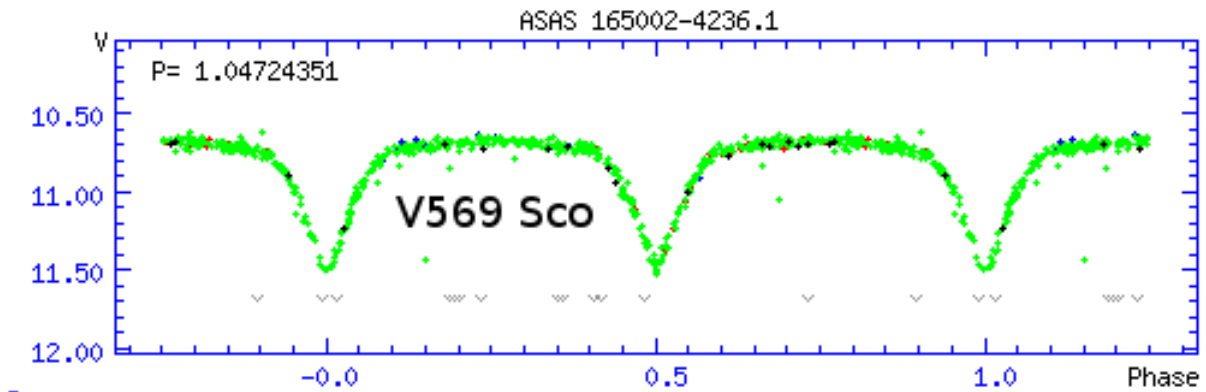
Periods and their variations

The SEB programme has had 174 eclipsers under observation for three years now. These are mostly EAs (ones with Algol-like light curves, usually the stars are detached from each other). EAs were chosen because period measurement, and detecting period change due to third bodies, could be done quite accurately. To measure their orbital periods you need to catch their primary (deeper) eclipses. Not as easy as it sounds: ephemeris predictions of eclipse minima can often be way off since based on poor or long-ago data. Sometimes observers miss shallow secondary eclipses and think every other primary is a secondary, so the listed period is double the true one. Or it's half, because secondaries and primaries are alike and someone thinks the next secondary is a primary. (I call this the P/2P ambiguity.) Here's a couple of examples where a P/2P mistake could easily be made – SZ Cru with a 0.1 mag secondary, and V569 Sco with very similar eclipses. (In each figure, the first eclipse is shown twice – phase 0 = phase 1). Light curves are from the ASAS-3 database (see References at end).



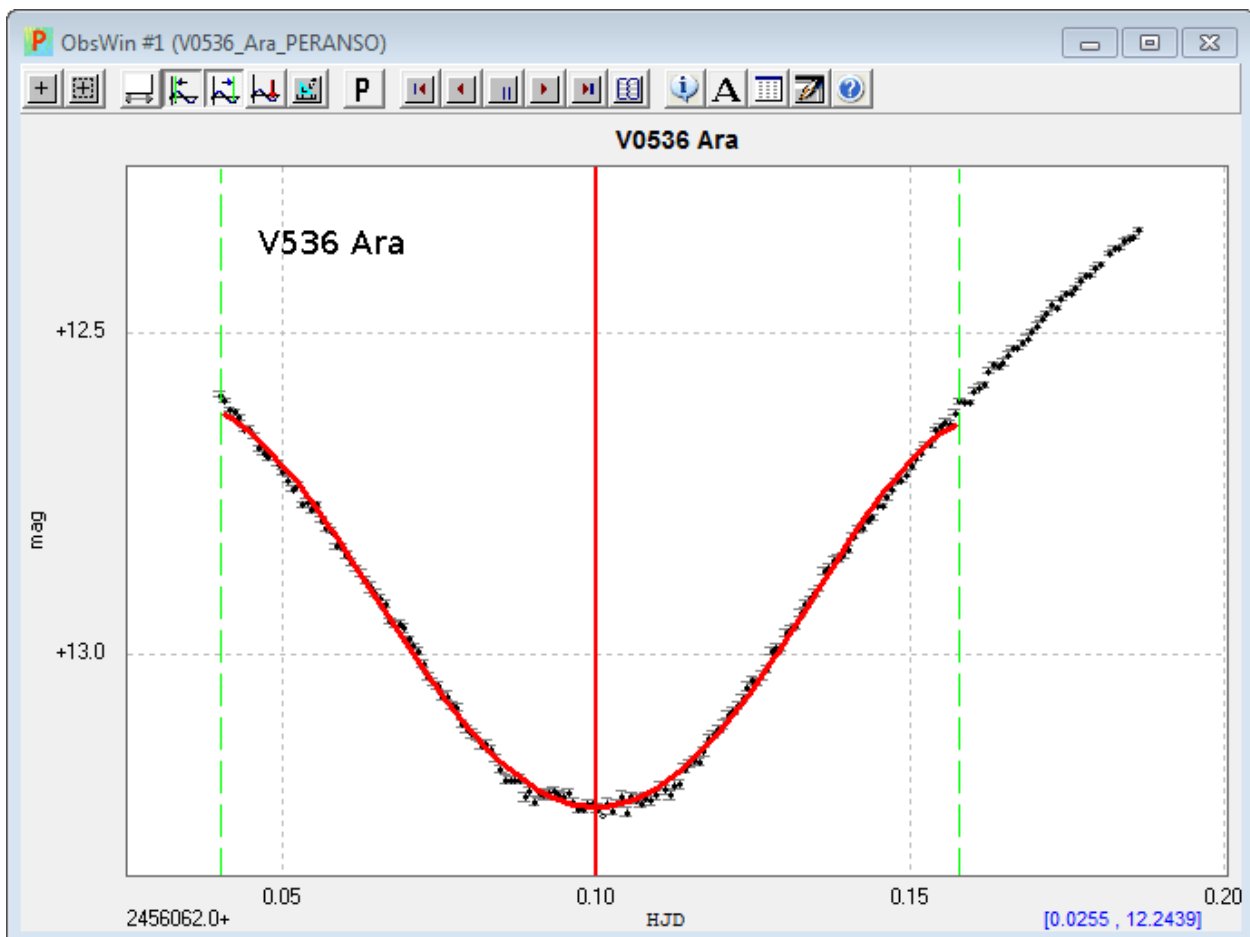
Despite this table full of eight balls, SEB observers have observed eclipses on 104 of our targets, and the SEB analysts have carefully measured those eclipse times. For 16 of the targets we have four or more

eclipse measurements. That can be sufficient to derive accurate, high precision linear Light Elements, i.e. the time of one particular eclipse, called Epoch 0, and the orbital period P – the time between successive primary eclipses. From E_0 and P , an ephemeris of future eclipses can be compiled.



Our method is this, as carried out by our analysts.

- 1 Measure the Time of Minimum (ToM) of each eclipse in Heliocentric Julian Dates. Several methods are used, all more accurate than eyeballing the eclipse curve; but there are times... Here's an example of one method, polynomial fitting. The eclipse of V536 Ara was observed by Margaret Streamer.



- 2 Carry out a linear regression on those ToMs against orbital cycle number (which can be derived safely from existing approximate LEs). That gives the most accurate possible period given the quality of the data, and a better estimate of E_0 than just choosing the first minimum measurement.

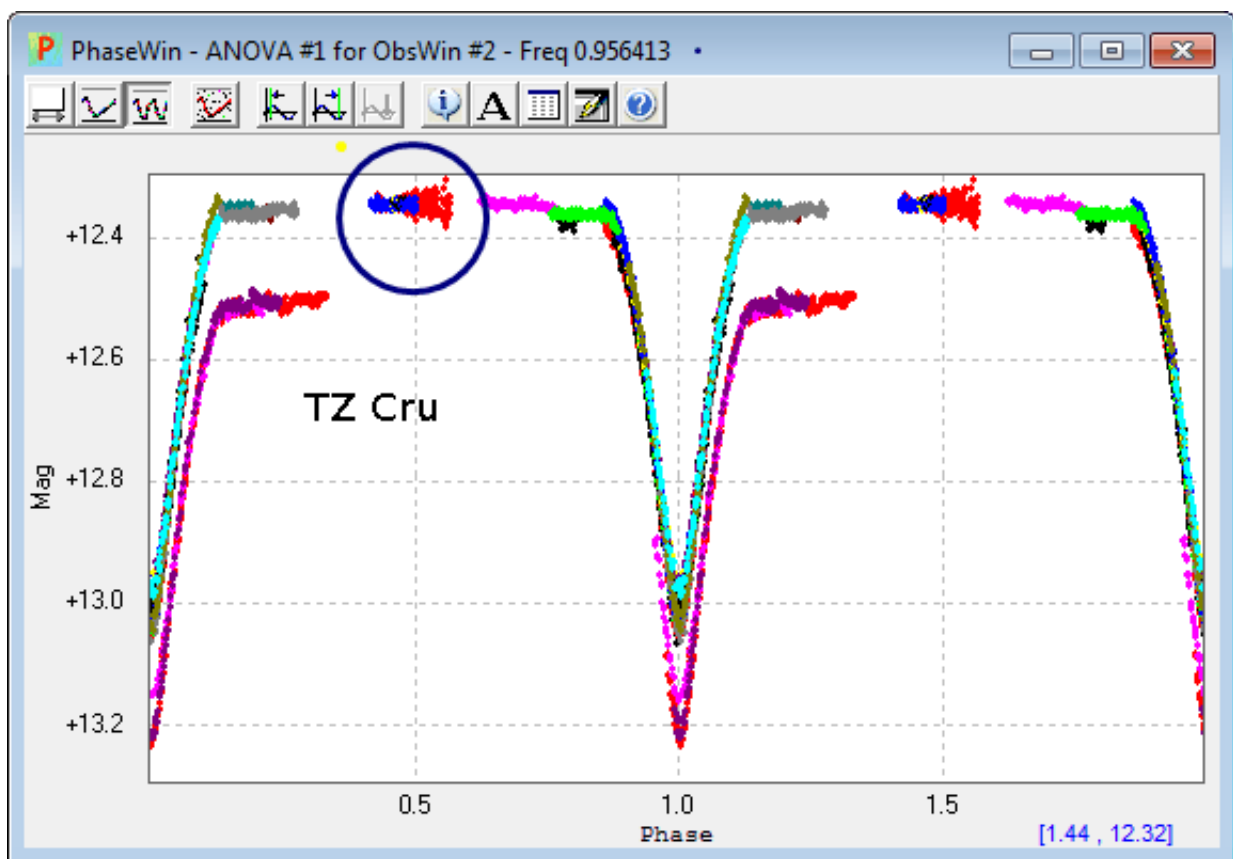
Consider for example the results on our best-observed system, TZ Cru – dozens of all-night CCD time-series observations by David Moriarty, Margaret Streamer and myself, analyzed by Margaret. From ten minima Margaret derived these LEs:

$$E0 = \text{HJD } 245\,6058.000\,14 \pm 0.000\,33$$

$$P = 2.091\,158\,9 \pm 0.000\,003\,3 \text{ d}$$

Note the all-important precision of these estimates. They mean, for example, that in ten years a primary eclipse can be predicted to a precision of 0.012 day, or ~16 minutes. So if someone times an eclipse in 2024 to within those error limits, they will have no reason to suspect a period change. But if their timing were, say, half an hour different and accurate to a minute, then period change has likely occurred. (One of our big headaches is that most discovery LEs do not come with precision estimates.)

All consulted sources for TZ Cru periods – GCVS (Samus *et al*, 2012), ASAS-3 (Pojmanski, 2002) and the O-C Gateway (Paschke & Brat, 2014), agree on a period half of ours. We think not. If we fold our data on that period, there is no sign of the expected secondary eclipse at phase 0.5, as this light curve of our data shows. (Don't worry about the vertical anomalies in the eclipses – these data are not yet normalised between different instruments.)



Discovering period change in a binary is vital for understanding its astrophysics. Orbital period can change because mass is transferred from one star to the other or is flung from the system – as happens with Algol and dwarf novae – or because of the internal rearrangement of one star (rarer). Again, there may be a third body in the system, perhaps a brown dwarf or massive planet, creating a sinusoidal variation in eclipse times over the years – the *light-time effect*. Plainly, accurate, high precision light elements and continuing year-on-year ToM observations are needed to enable the detection of such changes. The LEs and measured minima for most southern binaries are definitely not that. Often, there's only the discovery data – based on measuring star image sizes on photographs taken on different nights, plus a few visual estimates – most unreliable, and ASAS-3 patrol data – helpful for finding periods but less so for actual ToMs, hence epochs.

There is no real hope that professional night-on-night sky patrols will provide useful ToM data, because

to measure one minimum accurately you need a hundred or so magnitude measurements during the night spanning the entire eclipse. So the present project is the only real hope of obtaining vital period and period change data on southern eclipsers – and then less than 200 of them.

Here's some notes on the 16 targets for which we've measured four or more minima. The LEs are from the VSS Eclipsing Binary Database, downloadable from <http://www.variablestarssouth.org/information-and-resources/catalogues-a-databases>. Parenthesized numbers are the uncertainties in the right-most digits. Names gives the analyst first, then all observers whose results have been used.

Variable	Names	E0	P	Notes
V1243 Aql	Tom Richards; Terry Bohlson, Phil Evans, David O'Driscoll, Yenal Ogmen, TR, Margaret Streamer	2455064.7813(2)	1.406098(1)	P/2P ambiguity?
V0775 Cen	MS; David Moriarty	2455808.8962(5)	0.6636414(9)	No obs betw 1937 & 2010. EB not EA/DM?
AA Cru	DM; DM, MS	2455732.9292(4)	3.7876298(41)	GCVS gives half this P.
BE Cru	TR; DM, TR	2456084.0375(2)	2.221013(3)	Only 1 other obs since discovery 1937
SZ Cru	TR; DM, TR	2455748.929(3)	1.97431(1)	Discovered 1923. P shortening?
TZ Cru	MS; DM, MS, TR	2456058.0001(3)	2.091159(3)	Only 1 other obs since discovery 1926. P is twice the catalogue P.
RU Gru	MS; DM, MS	2454292.441(6)	1.893196(6)	No P change.
V0849 Sgr	TR; MS, TR	2455818.9605(8)	2.950664(5)	Possible P increase, but no obs since discovery
V5552 Sgr	George Stockham; DM, MS	2456152.0751(7)	1.347661(6)	GCVS gives twice this P.
V0490 Sco	DM; DM, MS	2452171.49(1)	3.003750(9)	Confusion in literature over identity of prim/sec eclipses.
V0569 Sco	MS; MS, TR	2452673.110(1)	1.0472441(1)	Only minima since discovery acquired by INTEGRAL.
V0626 Sco	DM; DM, TR, MS	2453099.81(1)	1.033682(4)	No other obs since discovery 1939, no P change.
V0634 Sco	Ranald McIntosh; DM, MS	2455769.9765(1)	1.2240285(3)	No other obs since discovery 1939, no P change.
LU Tel	TR; DM	2456096.1640(4)	1.571737(1)	Non-circular orbit?
AW Vel	MS; DM, MS, TR	2456274.1502(3)	1.99245(2)	DSCT-type pulsations
BC Vel	GS; TR, MS	2452500.79(1)	1.173596(3)	Possible P increase. EW mis-classified as EA/D.

What's next for these stars? First, after some literature checks and reviewing our data, it's time to

publish a paper on the periods and LEs of some of these systems. Observationally, with four or more ToMs and good LEs, it's time to move on to other investigations. We can keep a tab on any period change with another ToM every year or so. *That will also enable us to look for the light-time effect – the SPADES project.* What we need now is transformed B, V and Ic data at all phases so we can construct high quality light curves. From these we can develop astrophysical models of the systems – exciting work.

But some of these systems need special treatment. The pulsating AW Vel should get radial velocity spectroscopy on a large telescope so that its astrophysical parameters can be determined very accurately. (We have been granted time on the Anglo-Australian Telescope for another such that we're monitoring – TT Hor.) TZ Cru and V5552 Sgr need their secondary eclipses observed carefully, to resolve the P/2P ambiguity. We have already carried out extensive astrophysical analysis of V1243 Aql including modelling by Col Bembrick. But until its P/2P ambiguity is definitively resolved, we may be entirely on the wrong track.

Extending the SEB programme

So far we have concentrated on type EA eclipsers. With them, our concentration is on eclipse timing, to obtain accurate periods and look for period variations.

But that has observational downsides: on an observing night you first have to find which of them has a primary eclipse around midnight from your longitude. Frequently there are none. Only at later stages are we gathering uneclipsed data, for astrophysical modelling.

EBs and EWs however vary continuously as well as typically having shorter periods, so you can get a useful time series on any night. If we wanted to include these, our aim would be different – astrophysical modelling from the outset.

I think what we'd do is ask observers to carry out all-night times-series in B, V and Ic, and to transform their results before submitting to the analyst. If we chose one target in southern declinations at about every hour of RA, at V mag between 9 and 13; we should be able to get complete light curves fairly quickly.

I'd be most interested to hear your opinion on this suggestion, especially from the SEB research group members. Email me please, and we can discuss it at the conferences.

Hardware watch

Optec SSP5 photometer

The Astronomical Association of Queensland (AAQ) is selling a redundant Optec SSP5 Generation 2 photometer. The photometer is in excellent condition; Johnson B & V filters and software are included.

Information on the Optec Web Site: http://www.optecinc.com/astronomy/catalog/ssp/ssp_main.htm

The SSP-5 photomultiplier-based single channel photometer provides greater sensitivity than the SSP-3 and faster response time for occultation work. The SSP-5 has nearly 5 magnitudes greater sensitivity compared to the SSP-3. Using an optional extended red-sensitive PMT and Optec filters, the SSP-5 can provide accurate photometric measurements in the Johnson U, B, V and R bands.

Photometry of bright red variables is one area where amateurs can contribute scientific data. For some ideas of how it may be used, the AAVSO have a section on photometry at this link:

<http://www.aavso.org/content/aavso-photoelectric-photometry-pep-program>

The unit comes in a wooden box and weighs 5kg. Send offers via email to info@aaq.org.au.

If any Australian citizen would like to use it for a research project, the AAQ would consider providing the instrument for an agreed period at no charge except freight. As the instrument is the property of the AAQ, the user would be required to join the AAQ as a member for that period.

Please send a request with a very brief outline of proposed work via a private message to this posting with an email address for correspondence.

Terry Cuttle

President AAQ

www.aaq.org.au

Low-cost RCs

Oceanside Photo and Optical (OPT) in the US are offering a range of RC astrographs at very low prices.



Their offerings range from a 6" steel tube model for \$499 up to a 12" carbon fibre truss retailing for \$4495. These models appear on the OPT website under the TPO brand (Third Planet Optical). They appear identical to the models produced in Taiwan by GSO (Guan Sheng Optical). At least one European dealer is offering a 16" carbon fibre truss made by GSO for around \$7000.

GSO's web site (<http://www.gs-telescope.com>) lists several Australian and one NZ retailer as dealers.

Software watch

PinPoint V6 has been released by Bob Denny at DC3-Dreams. You'll need to update your subscription in order to get a copy. This new version can use the UCAC4 Catalog, released last year, which is the preferred catalog now for both astrometric and magnitude accuracy. PinPoint V6 also includes access to Astrometry.net to allow you to get an initial fix on your pointing for those cases where you haven't much clue where your telescope is aiming

MaximDL CCD V6 is expected to be released in February following beta testing. Now is the time to update your subscription. There are lots of improvements and new features including the following of likely special interest to VSS members.

Major upgrade to Photometry command

- Group-based analysis similar to Stack tool
- Multispectral analysis
- Unlimited input files
- Reject images based on quality
- Astrometric or auto star match star identification

Support for PinPoint V6

- Astrometry.net integration for all-sky solving
- UCAC4 support
- Hot pixel detection and removal for more robust solving
- Improved point-spread function fitter
- Deprecated support for obsolete catalogs GSC (non-corrected) and USNO SA 2.0
- Now "modeless", allowing the PinPoint dialog box to remain open when switching images, using other commands, etc.

ASCOM Switch control

- Control hardware switches such as power, lights, reboot equipment etc.

Observatory webcam integration

- Live view of inside of observatory via webcam
- Switch control panel (handy for operating lights etc.)

Automatic pointing refinement using PinPoint

- Takes pointing exposure to verify telescope position
- Resynchronises automatically
- Centres target precisely

Automated pier flipping

- Detect telescope approaching limit
- Pause imaging sequence
- Flip telescope over pier
- Automatic pointing refinement
- Relocate guide star
- Continue image sequence

About

Variable Stars South is an international association of astronomers, mainly amateur, interested in re-searching 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 Dr Tom Richards, 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. The annual subscription is NZ\$20 and the membership year expires on April 30th. 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 you will get a link to pay by PayPal's secure on-line 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. 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, with a copy deadline of the thirteenth of the month, though earlier would always be appreciated.

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