Newsletter 2011-4

November 2011

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Col Bembrick has not been observing lately and this is why – his Mt Tarana Observatory 40cm SCT being removed from the mounting for repairs by Col to the RA bearings which ground to a halt after 10 years of use.

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From the Director – *Tom Richards*

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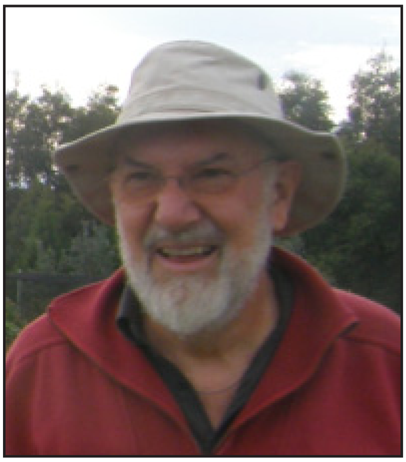

Second VSS Colloquium and NACAA – are you coming to Brisbane this Easter?

Easter's getting close! It's time to plan for the **NACAA Conference and VSS Colloquium.** The colloquium, open to anyone not just VSS members, is on Good Friday, April 6th, only four full moons away from the December total lunar eclipse. The main conference is Saturday and Sunday, April 7-8, and on the Monday is the next in the series of Trans-Tasman Symposia on Occultations. The venue is the University of Queensland St Lucia campus. NACAA typically addresses the research- and technically-oriented amateurs, as well as education and outreach issues. Professional representation is usually strong.

You can find out all about **registration, accommodation, and presentation guidelines** from http://www.nacaa.org.au/2012/about. Conference organisers are specifically encouraging presentations on photometry and variable stars for the main conference; so if you have an interesting story to tell that will encourage or inform the attendees about variable stars, do submit a proposal for an oral presentation or poster, or even workshop, to the general conference.

But Friday is our day – while everyone is still fresh. I'm hoping for a big turnout of variable star enthusiasts, from amongst VSS membership and the wider astronomical community. This will be the occasion to get to know people by a little more than their email, and to share the research we are doing. Have you been working on a particular star? Or class of stars? How about a poster on it for the main conference, and/or an oral presentation to the colloquium? Doing some analysis work? A presentation on methods and results would be valuable. Techniques and technology are important to share, so if you're working on a hardware, software or observing development, please present on it. There's plenty of that going on in VSS, from new ways of making visual estimates to DSLR techniques. And then there's the VSS projects – I'd hope that every project leader will have something to say about their project.

Presentations: Like the main conference, oral and poster presentations will be a major focus. In addition there are two workshops proposed – David Benn on his VStar photometry analysis software, and me on transformation coefficients. A day is very short for all that we have to talk about, so I'd ask presentations to be 20 minutes maximum, including 5 minutes for discussion, and any more workshops to be 40 minutes maximum.

Please email me with your **proposal for a presentation** of any sort to the colloquium. What do I need to know?

- Your name and state/country,
- Is this proposal about an oral address or workshop or something else you have in mind? (Posters to main conference please)
- Title and abstract (you can modify the abstract later for inclusion in the programme).

Proposals should reach me by the end of January, and I'll advise about acceptance after that. Please try to plan your presentation to be very visual – a data projector will be available if you bring visuals on a USB thumb drive. And of course you're welcome to bring handouts for distribution. Please be prepared to make your visuals, e.g. Powerpoint, available for inclusion on a colloquium DVD. And the same goes for handout files or a written paper, which are both strongly encouraged.

See you there!

Southern Binaries DSLR Project – *Mark Blackford*

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In the August 2011 Newsletter I introduced the SBDSLR project and I refer the reader to that article for details. The main project goal is to observe (mostly) southern eclipsing binaries to measure precise Times of Minimum (TOM) over a number of years to detect variation from predictions. These may result from apsidal motion, light travel time effects (due to the orbit of a third component) and mass transfer.

Target stars are bright and therefore suitable for imaging with DSLR cameras and standard telephoto lenses. However, tracking mounts are required to record multi-hour time series of individual eclipses.

The target list has been expanded to 61 objects currently. I am indebted to Mati Morel for his help in selecting comparison stars for the original 12 targets, and to Peter Jaquiery for tracking down the most recent published ephemerides for all targets. To simplify eclipse predictions a catalogue file has been compiled for use with David Motl's Ephemerides program. This will be updated as new ToMs are measured and new targets added. The catalogue file will be available from the project web pages, however for the most recent version please email me directly.

Quite a few targets have not been observed for many years. Eclipse predictions based on old data are not very reliable so considerable effort is sometimes required to record an initial eclipse. For instance, I finally caught the descending part of an eclipse of GG Lupi after some 10 hours of imaging spread over 4 separate evenings. Future eclipses can now be more accurately predicted, but we will have to wait until early 2012 to observe GG Lupi again.

Observations to date

At the time of writing I am the only contributor to the SBDSLR project. Hopefully that will change in coming months as several people have recently expressed interest in DSLR photometry.

Successful observations made up until November 10th, 2011 are shown in Table 1. Images were measured using AIP4WIN and analysed in my own Excel spreadsheets. Three comparison stars and one check star within the frame were chosen, with V and B-V as close to the variable as possible. The variable and check star were reduced against an ensemble of the three comparison stars.

Target	Type	ToM (HJD)	Comments
DX Aqr	Primary	2455802.08408(37)	Clouds near mid eclipse
DX Aqr	Primary	2455820.98277(1)	
delta Cap	Secondary	2455852.982(2)	Extremely shallow, need Primary
V716 Cen	Primary	2455746.91049(18)	Very little descending curve
AA Cet	Primary	2455825.14292(0)	
BG Ind	Primary	2455783.05777(1)	
BG Ind	Secondary	2455837.95372(12)	Very little descending curve
eta Mus	Secondary	2455723.02322(18)	
eta Mus	Primary	2455776.93453(22)	
U Oph	Secondary	2455751.04162(4)	
KZ Pav	Primary	2455798.96750(45)	
KZ Pav	Primary	2455817.01473(0)	
zeta Phe	Primary	2455810.04472(31)	Clouds near mid eclipse
zeta Phe	Secondary	2455845.94370(30)	
RS Sgr	Secondary	2455772.03511(43)	
RS Sgr	Primary	2455778.07330(3)	
V505 Sgr	Secondary	2455838.96787(16)	
mu1 Sco	Primary	2455729.99517(9)	Very little descending curve
mu1 Sco	Primary	2455797.97196(6)	
BB Scl	Primary	2455844.11812(2)	

Table 1. Preliminary Times of Minimum of SBDSLR Project targets.

Times of Minimum were determined using Peranso and are listed in the accompanying table. However these ToMs (and errors in brackets) should be considered preliminary at this stage.

One advantage of DSLR photometry is the simultaneous recording of red, green and blue channels. With careful calibration these may be transformed to Rc, V and B, respectively, in the standard magnitude system. Therefore eclipse light curves can be constructed in each of these colours. For a number of reasons, V light curves are (generally) significantly less noisy than Rc and B light curves. Therefore ToMs were measured using only the V data.

Some examples

A few interesting examples are presented below. All plots show transformed magnitudes as a function of Heliocentric Julian Date with a vertical range of 1 full magnitude to aid comparison between plots.

Target B, V and Rc light curves are shown as well as V for the check star, adjusted by the amount shown in the legends to allow display on the same vertical scale.

The time axis range has not been standardised.

1. eta Muscae secondary eclipse

In retrospect I should have chosen a target with larger magnitude range for my first observation, but Ed Budding had a particular interest in eta Muscae at the time and new eclipse timings were sought. Primary and secondary eclipses have similar depth of about 0.1 mag in V.

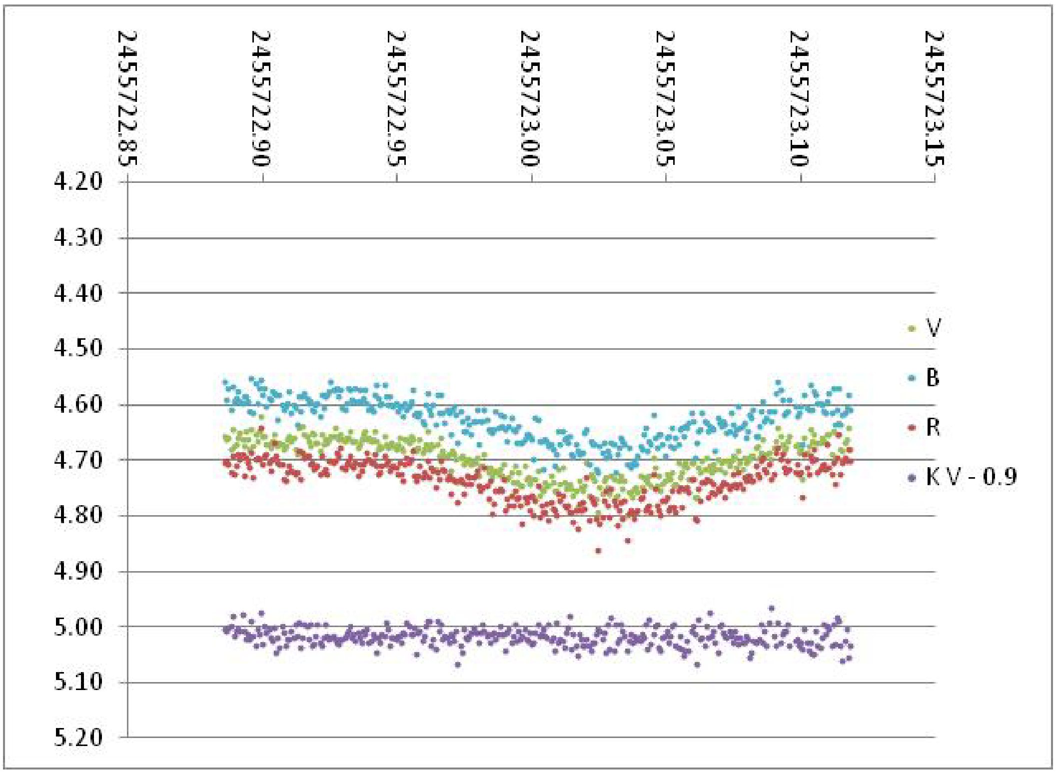


Figure 1. Light curve of eta Mus showing secondary eclipse.

The eclipse is clearly visible in Fig 1 above despite scatter in the data. A primary eclipse was observed some two months later but was not favourably positioned in the sky, leading to noisy data again. The observing season starts again in February and eta Muscae will be a high priority target, as Ed explains:

“The study of Bakis et al (2007) of this system noted the significant discrepancy between the radial velocity of the bright visual companion and the centre of gravity of the close eclipsing binary component. These two stars - although close on the sky - are quite well separated in space. They were, however, believed to be physically related and an orbital period of about 100,000 y had been posited. Bakis et al disputed the physical connection on the grounds of the disparity in radial velocities. What has been noticed since, however, is the strong likelihood of another component to this multiple star - relatively close to the eclipsing pair. Tentative evidence - even from the few recent ToMs of the VSS - support this idea, and may well help elucidate the properties of this (relatively low mass) additional companion in more detail.”

2. delta Capricorni secondary eclipse

Recently Ed Budding requested observations of delta Capricorni, however this proved particularly challenging. At V 2.8 mag it required large defocus and relatively short exposures of 20 seconds at f4. Over 600 images were recorded at 30 second intervals.

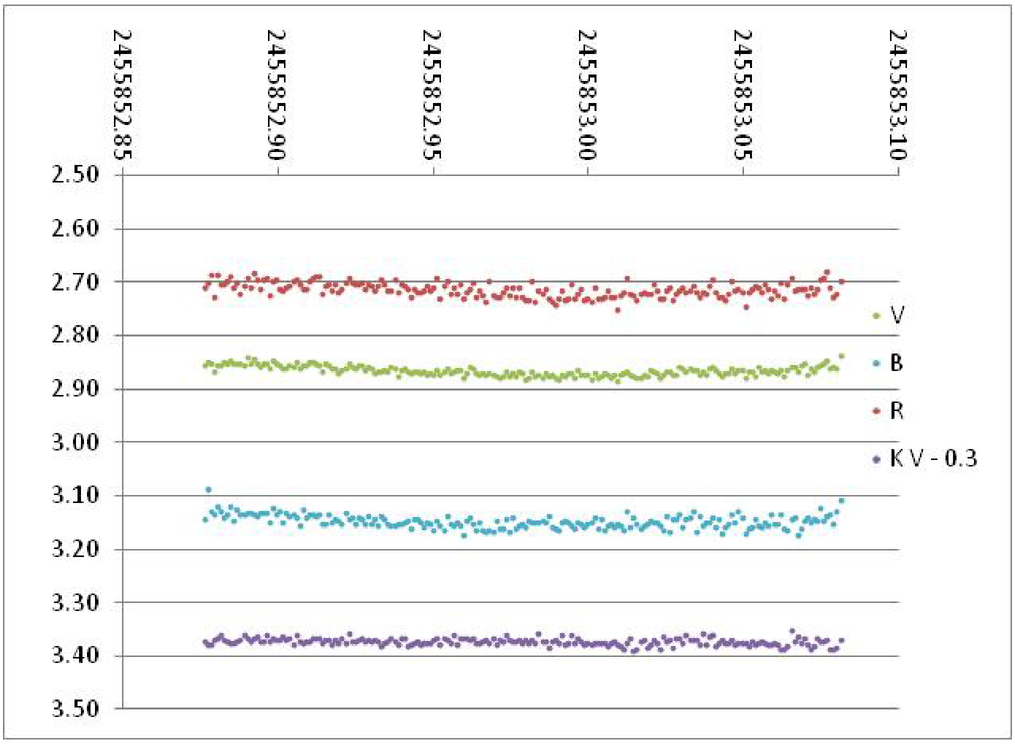


Figure 2. The very shallow secondary eclipse of delta Capricorni.

Data was binned by 3 in order to reduce noise in the light curves. The plot in Fig 2 shows an extremely shallow secondary eclipse of only 0.02 mag in V throughout the session. A ToM was determined from this data but it is probably not reliable.

Primary eclipses are approximately 0.25 mag deep and should provide accurate ToM measurements. The weather in Sydney, however, has so far thwarted attempts to observe a primary eclipse.

The interest in delta Capricorni is explained by Ed:

“This is one of the brightest eclipsing binaries in the sky, and thus a bit of a challenge for conventional observing techniques. It has been thought to be a fairly standard detached pair of near-Main Sequence stars and somewhat neglected. Wood and Lampert reported apparent changes in the shape of the light curve, however, in 1963. Recent data suggest that Dorren et al’s (1980) ephemeris is not being exactly followed. It could be that the period value needs refinement. Or maybe there is some additional peculiarity: the primary does not have such a typical late A type spectrum.”

3. RS Sagittarii primary eclipse

Sky conditions were particularly good this evening as shown by reduced scatter in the light curves in Fig 3 overleaf, V in particular. However, a ~0.02 mag brightening in the latter third of the check star light curve requires some explanation. Inherent variability of the check star is conceivable but a more likely reason is differential primary extinction and/or secondary extinction.

An advantage of DSLR photometry is the wide field of view afforded by conventional camera lenses compared with imaging through a telescope. However, this can be a problem as well. FOV with my

180mm lens is ~7 x 4.7 degrees and at low elevations this can make for significant differences in airmass across the FOV. For this particular observation the target elevation ranged from 90 degrees (airmass 1.00) at the start of the image series to 28 degrees (airmass 2.15) at the end.

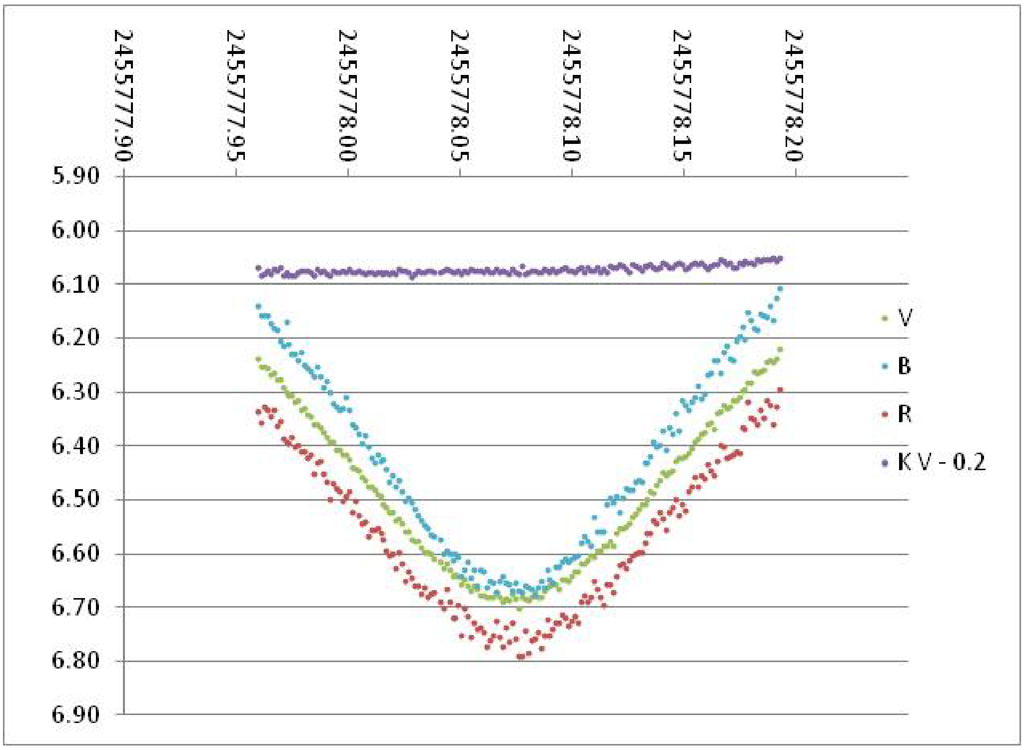


Figure 3. Primary eclipse of RS Sag.

The lessons here are

1) Wherever possible we should use comparison and check stars with V magnitudes and B-V colours very similar to the target star, and at small angular separation;
2) If such close comparisons are not available then observe at high elevations to minimise airmass; and
3) When it is necessary to work at greater airmass then correction for both primary and secondary extinction will have to be incorporated into the analysis procedure.

Ed explains the interest in RS Sagittarii:

"This has been considered as a fairly standard detached pair, but a recent study of Bakis et al considered an earlier conjecture of Cerruti and de Laurenti that the system might actually be a semi-detached (Algol type) binary to be supported by more recent evidence. If that is the case, then one would expect ToM variations, because the Algol binaries are in a process of mass exchange that generally causes the period to change. New ToM data may help confirm or deny this proposal."

Conclusions

The Southern Binaries DSLR project is in the early stages of development. Project objectives and the target list will be refined as interesting systems come to light and observer numbers and skills improve.

If you are interested in participating please contact me at the email address above.

References

Bakis, et. al., Mon. Not. R. Astron. Soc. 382, 609, 2007

Cerruti, M. A., & de Laurenti, M. A., Acta Astron. 40, 283, 1990

Dorren, J.D., et. al., I.B.V.S. 1826, 1980

Wood, F. B. & Lampert, G., Pub. A.S.P., 75, 281, 1963

Southern Eclipsing Binaries and the SPADES Project -*David J W Moriarty*

Summary of observations May to October 2011

As a general comment, I found that many of the predictions for eclipsing variables based on the GCVS ephemerides were not correct, so the principal aim in this first season of observations was to check and where necessary, update the ephemeris elements. The HJD times of minima in Table 1 are approximate. The V filter (Johnson) was used for all imaging.

Star	Date & Time	Eclipse	O – C (d)	Time (HJD)	Period (d)	Source
V775 Cen	2011-8-25 8.32 pm	P	- 0.011	2455798.939	0.6636425	Motl
V775 Cen	2011-9-4 7.30 pm	P	- 0.009	2455808.896	“	“
V775 Cen	2011-9-7 7.23 pm	S	0.000	2455811.891	“	“
V775 Cen	2011-9-11 6.56 pm	S	0.000	2455815.872	“	“
AA Cru	2011-6-3 19.07	S	- 0.025	2455715.8804	3.78763	Krakow
AA Cru	2011-6-20	P (?)	- 0.017	2455732.9325	“	“
AA Cru	2011-6-22	Ascent ex S		ca 2455734.84	“	“
AA Cru	2011-7-24	P	- 0.019	2455767.020	“	“
AF Cru	2011-8-1	P	+ 0.006	2455774.85	1.895685	Motl
AF Cru	2011-8-18	P	+ 0.004	2455791.9091	1.895685	Motl
BE Cru	2011-6-19	Initial descent		2455731.839		
BE Cru	2011-8-17	P	+ 0.006	2455790.852	2.220996	Motl
SZ Cru	2011-7-5	S	+ 0.013	2455747.943	1.9743	Dvorak a
SZ Cru	2011-7-6	P	+ 0.011	2455748.928	“	“
SZ Cru	2011-7-8	P	+ 0.011	2455750.902	“	“
TZ Cru	2011-8-2	P?		2455775.86	1.045617	Motl
TZ Cru	2011-8-3	P?		2455775.847		
FV Lup	2011-8-3 7.25 pm	P	- 0.003	2455776.893	4.102915	Krakow
FV Lup	2011-8-5 9.12 pm	S	- 0.020	2455778.967	“	“
BX Mus	2011-6-17 >11.45 pm	P	+ 0.11	ca 2455730.07	2.23984	GCVS
V384 Nor	2011-9-8 < 8.10 pm	P	> - 0.019	2455822.92	3.97413	GCVS
GM Nor	2011-7-28 < 8 pm	Ascent		<2455770.9305	1.8845692	Krakow
V457 Sco	2011-9-21 8.07 pm	P	+ 0.007	2455825.922	2.00738	Dvorak a
V634 Sco	2011-7-27	P	+ 0.037	2455769.972	1.224028	GCVS
V640 Sco	2011-8-8	P (?)	0.000	2455781.886	1.71302	GCVS
LU Tel	2011-7-3 19 pm	P	+ 0.018	2455773.957	1.57173	GCVS
IZ Tel	2011-9-30 ca 7.40 pm	P	+ 0.030	2455834.905	4.880179	O-C Gateway

Table 1. SPADES Targets. Summary of observed times of minimum eclipse or light changes close to minimum eclipse times. P = primary minimum; S = secondary minimum; d = day.

Comments

AS Carinae. Magnitude range: 11.0 – 12.2 p 11.556 V

26 May 18.25 – 22.15 no change, but I had made an error in the entry of ephemeris data.

Predicted minimum was in fact at 15.20 hours. ASAS light curve indicates P = 2.765858 is correct, not 2.76593 (GCVS).

DO Carinae. Magnitude range: 9.3 – 9.5 p 9.000V

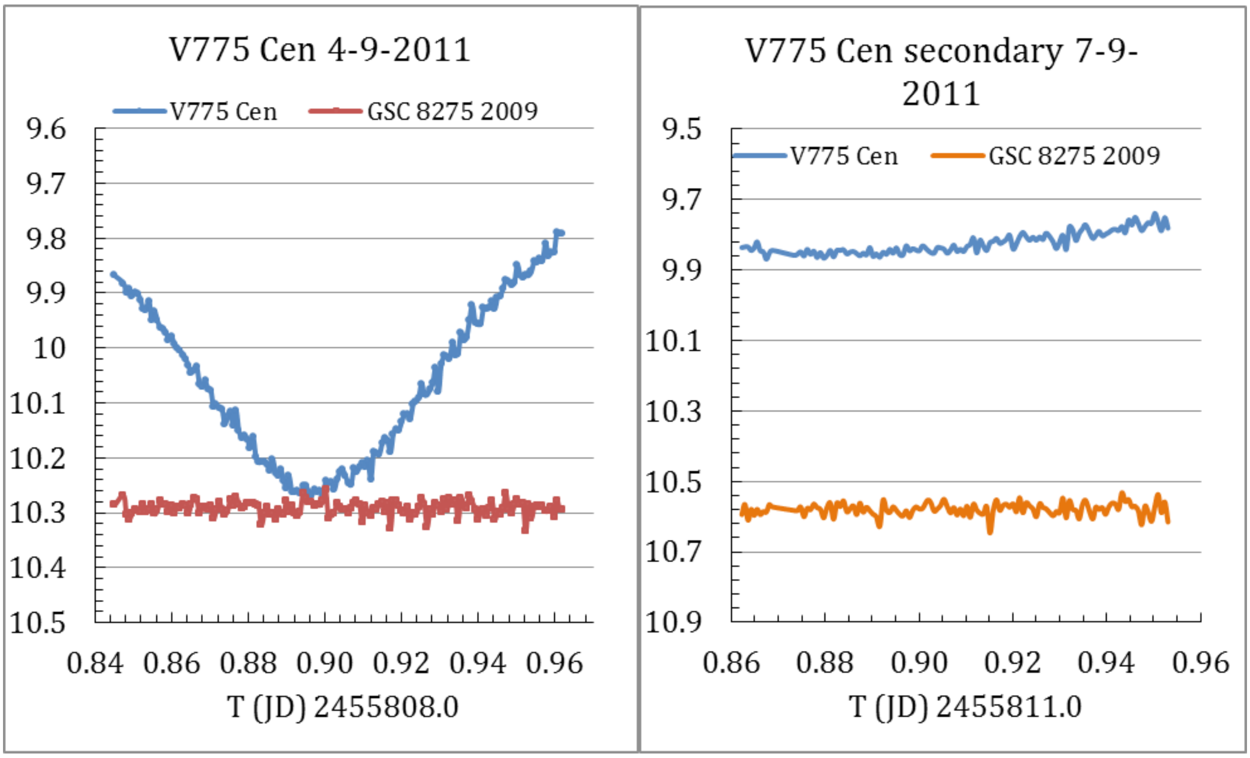
11 May and 26 May; both nights no change. GCVS elements had predicted a minimum at 20.35 on 11 May. The Dvorak 2004a ephemerides did not predict eclipses at those times and dates, so try Dvorak 2004a for future observations.

V762 Centauri. Magnitude range: 10.3 – 10.8 p or 11.424 V

A minimum was predicted for V762 Cen at 9 pm 26 June, but clouds arrived. There was a small decline in the half hour or so before the clouds were too thick, so GCVS elements are probably correct. Note that the ASAS phase diagram corresponds well with the GCVS period.

V775 Centauri. Magnitude range: 9.7 – 10.7 V

The GCVS ephemeris elements are not correct; in particular, the actual period is half that listed on the SPADES project web page. The elements used for the Motl program are correct: cf ASAS and O-C Gateway. My data (Table 1) agree reasonably well with those. However, there was a problem with the star that was specified originally as the reference (GSC 8275 1275): it is listed as NSV 20010. The new reference and check stars are GSC 8275 1656, V mag 8.43 and GSC 8275 2009 V mag 10.492 respectively. The check star magnitudes on 7 and 11 September were about 0.25 brighter than those recorded prior to 7 September. Magnitudes of some other stars in the field also varied, so more work is required to determine whether the variability was intrinsic to the stars or to observing conditions. The instrumental magnitudes were brighter on 7 and 11 September than earlier, but the times and altitudes were similar, so it seems unlikely that changes in air mass could be involved.



AA Crucis. Magnitude range: 11.2 – 11.7 V

The data I recorded indicate minima occur about 40 - 50 minutes earlier than calculated with Krakow ephemeris elements (Epoch 2452502.096; P = 3.787636) and about 1.2 – 1.5 hours earlier than those with the elements of Dvorak (2004 a).

The GCVS ephemeris elements on the SPADES Target page are not correct (Epoch 2425331.480; Period 1.89382). The period is actually double that given in the GCVS.

Note: there were variations (noise?) in the magnitudes of the reference star (8979 0134) on 3 June; possibly due to its placement near the lower edge of the CCD field.

AF Crucis. Magnitude range: 9.76 – 10.53 V

The GCVS period is wrong: it predicted minima 5 hours earlier than those I recorded.

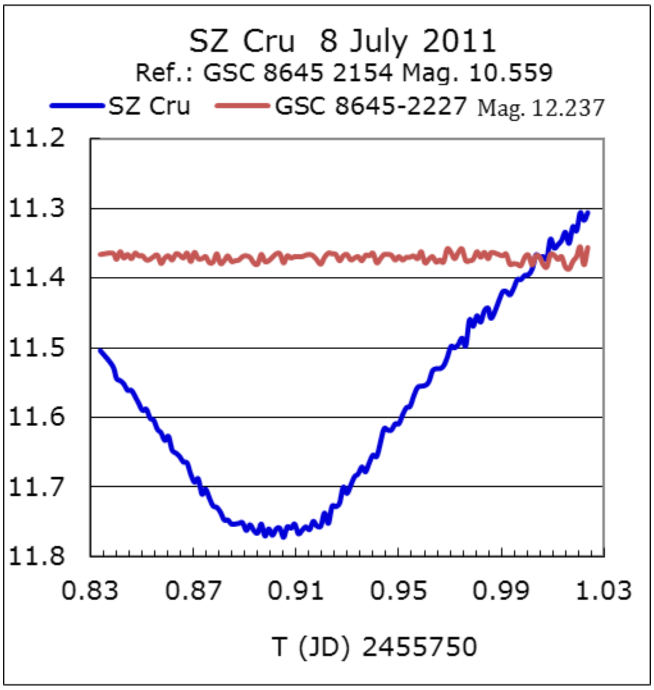
The ephemeris elements supplied for Motl's program agree closely with my observed data. The ASAS period that fits best is 1.8956825.

BE Crucis. Magnitude range: 12.5 – 13.2 p 12.727V

A minimum was predicted by GCVS 15 June at 9.30 pm (2455727.981), but in fact there was no change from maximum brightness, so GCVS elements are wrong.

The ASAS and O-C Gateway elements used by Motl (Ep = 2453401.054, P= 2.2209960) predicted a secondary minimum on 19 June at 9.44 pm and a primary on 17 August at about 6.20 pm. I observed a descent starting at 6.10 pm on 19 June (before clouds intervened), so if the 9% duration is correct, then the minimum would have been at about 11 pm, ie more than 1 hour later than predicted. However, the ASAS period does not indicate a deep secondary minimum. The timing difference and apparent lack of a secondary minimum in the ASAS data indicates more work is needed to check light elements for BE Crucis. BE Cru was at primary minimum on 17 August at 6.30 pm, which is close to the predicted time by Motl.

SZ Crucis. Magnitude range: 11.4 – 12.4 12.499 V



The GCVS elements are not correct. The updated ones by Dvorak give predictions about 15 minutes earlier than observed. The primary minimum depth was about 0.75 magnitude, i.e. less than that in the ASAS light curve (11.4 – 12.4), and the secondary depth was about 0.07 magnitudes. The derived magnitudes were about 0.6 – 0.7 brighter than the ASAS V mags.

TZ Crucis. Magnitude range: 11.8 – 12.4 p 12.291V

Observations on 2 August 6.15 – 7.10 pm and 3 August 6.15 – 6.30 pm showed magnitudes of 12.6 both nights and no change on the 2 August, but a rise on the 3rd starting at 6.20pm. As the derived magnitudes of the check star were 12.3 each night and its catalogue magnitude is 12.284, the data suggest that TZ was indeed at a minimum on both nights. Therefore, the GCVS ephemeris elements are wrong, whereas those in the Motl database (ASAS and O-C Gateway) are probably closer to the correct values. However, as TZ was at minimum 1.5 hours after the predicted time on the 2nd with no sign of a rise, more information is needed to revise its elements.

FV Lupi. Magnitude range: 10.8 – 11.9 p 10.250V

A descent towards a primary minimum was observed on1st July. FV was apparently at primary minimum when observed on 3 August and a secondary minimum was recorded on 5 August. The data agree best with the Krakow elements: Period = 4.10 2915 and Epoch = 2452502.77.

BX Muscae. Magnitude range: 12.6 – 13.1 p 12.705V

Depth secondary minimum = 0.02 (GCVS)

A descent from V mag. 12.67 to 13.1 was observed on 17 June, about 2.5 - 3 hours later than calculated with GCVS ephemeris.

GM Normae. Magnitude range: 10.58 – 11.03 V

Observed ascent from 8.20 pm onwards 28 July, consistent with 7.30 pm prediction from Krakow elements (Epoch = 2452501.1688, P = 1.8845692). GCVS elements are not correct (predicted minimum was 8.52 pm).

VV Normae. Magnitude range: 12.1 – 12.3 p;   13.055 V

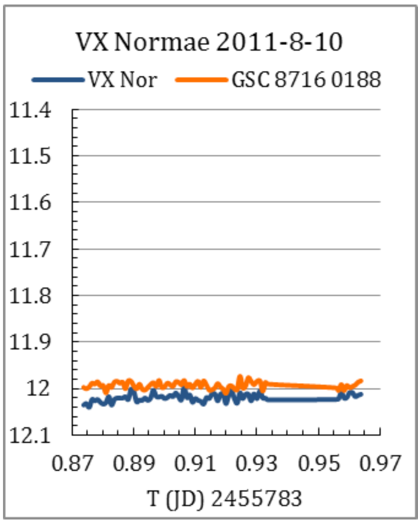
A minimum was predicted by GCVS elements at 1 September 9.23 pm. No change was observed between 7 and 9.45 pm. Derived magnitude: 12.7; check star (8337 0083, V mag 12.003) derived mag. was 12.5. Therefore, it is probable that the VV was at maximum. No period available from ASAS (Dvorak 2004 b); only poor data in the original 1930 paper (BAN 194).

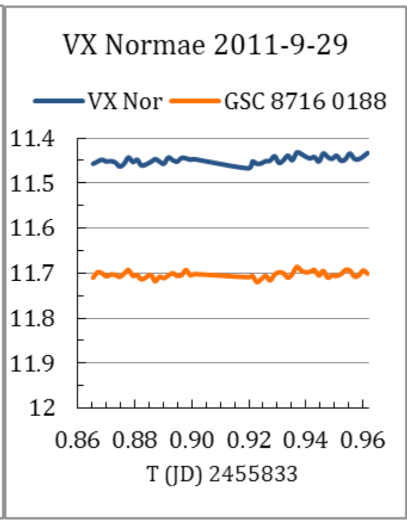
Note: VV and the reference stars have very close companions, and the low magnitude required 3 minute exposures. More resolution and shorter exposure periods required with a larger telescope aperture.

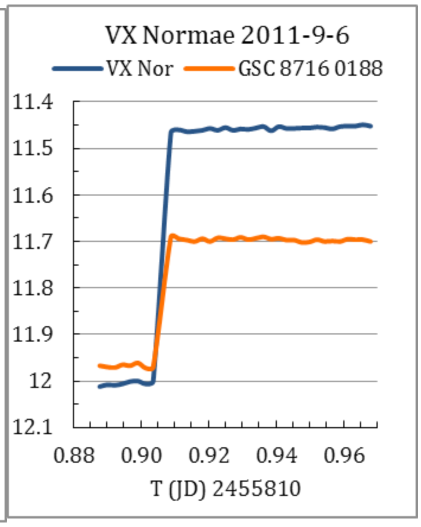
VX Normae. Magnitude range: 11.2 – 11.5 p. 11.216 V

Observations were made when Dvorak elements predicted minima for 10 August, 6 September and 29 September; however, no change was observed. There was a puzzling change in brightness for VX and the check star (GSC 8716 0188, V mag 11.693) on 6 September when the CCD field was moved slightly. The magnitudes of VX and the check star jumped from 12.0 and 11.97 respectively, to 11.45 and 11.69 respectively. Magnitudes for 10 August were similar to the first set on 6 September, whereas magnitudes for 29 and 30 September were similar to those of the latter part of 6 September.

All VX Normae data were obtained with 1x1 binning.







V384 Normae. Magnitude range: 10.07 – 10.36 V

A minimum was in progress and ended during the observing run on 18 September. Therefore, the mid eclipse would have been earlier than predicted at 8.40 pm; possibly up to 5 hours earlier as the period is 3.974 d.

V457 Scorpii. Magnitude range: 10.6 – 11.4 p

A primary minimum was observed on 21 September, consistent with elements of Dvorak 2004a.

V491 Scorpii. Magnitude range: 12.8 – 13.3 p 12.414V

No minimum observed on 14 June between 9.30 and 11.15pm (GCVS predicted minimum at 9.50 pm). No other data available in ASAS or O –C Gateway.

V604 Scorpii. Magnitude range: 12.1 – 12.4 p. 11.791 V

The difference between the check star and V604 is about 0.3 magnitudes on 2 August and 0.7 mag on 23 September, which is when a minimum was predicted. Therefore it was possibly already at minimum during the time I observed — 6.30 to 7.30 pm. Clouds arrived at 7.30. There was no change in intensity during that period. The ASAS data do not show a light curve (cf Dvorak 2004b).

The data based on the same ref star give different values for the magnitude of the check star. I used 2x2 binning for the earlier data and 1x1 for the later; could that affect values? I used comparable aperture and gap widths.

V632 Scorpii. Magnitude range: 11.1 -11.7 V

Observed from 7.30 to 8 pm 6 August; no change; apparently at maximum magnitude 11.2; check star 11.8 (Catalogue V mag 11.443). GCVS original elements predicted a minimum at 8 pm (E = 2429049.52, P = 1.610168). Dvorak (2004a) revised these to E = 2452834.734 and P = 3.2204; no minimum would have occurred on 6 August with these elements.

V634 Scorpii. Magnitude range: 11.7 – 12.3 p. 11.711 V

Minimum at 9.20 pm 27 July was 50 minutes later than expected.

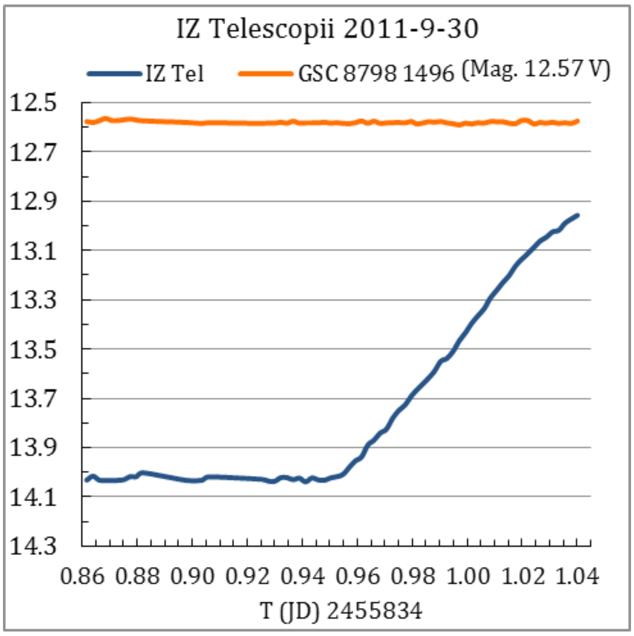
V640 Scorpii. Magnitude range: 12.8 – 13.5 p. 12.121 V

A minimum, probably primary, was observed at 7.15 pm 8 August as predicted by GCVS elements. A full light curve is required to check.

IZ Telescopii. Magnitude range: 12.1 – 14.1 V

Type: EA and DSCT. The Delta Scuti oscillation frequency is 13.6/day (1.76 hours) with magnitude range of 0.046.

A primary minimum (mag 14.03) was underway at 6.40 pm until 8.45 pm, then a rise until I stopped at 11 pm. At that trend, it should have reached maximum around 12 30 am. These data agree reasonably well with the elements listed in the O-C Gateway (Epoch = 2451877.04; P= 4.880179) whereas the GCVS elements in the SPADES file (Ep 2436787.499, P 4.880219) and also used by Motl indicated a minimum at 9.50 pm, which was an hour or so after the rise had started.



Therefore use the O-C Gateway elements.

From the ASAS light curve, IZ would spend about 1.7 – 2 hours at minimum, and take about 17 – 18 hours in total for an eclipse. Therefore the mid eclipse was at about 7 40 pm (HJD: 2455834.905)

The derived magnitudes were close to the catalogue V mags.

LU Telescopii. Magnitude range: 12.4 – 13.5 V

Observed minimum, mag 14.3 at 9 pm, 30 minutes after the predicted time by GCVS elements. Check star catalogue mag 13.303; derived mag was 13.56.

Notes

Why were some derived magnitudes different from catalogue V magnitudes, and others similar? See foe example SZ Cru and V634 Sco versus IZ Tel.

TW Crucis. Type EW/KW. Contact eclipsing binary system. Magnitude range: 12.4 – 12.9 p

TW Cru is not a SPADES target. I chose this short period system as an exercise for learning CCD photometry techniques.

Three primary and five secondary eclipses were observed between 5 May and 4 July, with a 67% portion of a light curve on 27 May. Three sets of ephemeris elements were available:

1. GCVS, based on Bruna (1930): E0 = 2424776.1574; P = 0.3881358

2. Dvorak 2004a: E0 = 2453106.7530; P = 0.3881358
3. Krakow: E0 = 2452500.282; P = 0.38814626

The times of minima differed from the calculated values with the GCVS elements by over 5 hours, 60 – 70 minutes later with the Dvorak elements and 4 hours with the Krakow elements (Table 2).

Date	Time (HJD)	Type of minimum	O – C (GCVS)	O – C (Dvorak)	O – C (Krakow)	O – C (GCVS+P/2)	O – C (VStar)
2011-5-5	2455686.930	s	0.220	0.044	0.161	0.026	-0.0036
2011-5-12	2455693.9183	s	0.222	0.046	0.163	0.027	-0.0018
2011-5-13	2455694.888	p	0.226	0.046	0.167	0.032	-0.0024
2011-5-24	2455705.9534	s	0.224	0.049	0.165	0.030	0.0008
2011-5-27	2455708.8629	p	0.223	0.047	0.164	0.029	-0.0007
2011-5-27	2455709.0558	s	0.222	0.046	0.163	0.028	-0.0019
2011-6-14	2455726.9166	s	0.228	0. 053	0.169	0.034	0.0043
2011-7-4	2455746.9042	p	0.228	0. 053	0.168	0.034	0.0025

Table 2 Comparison of O-C times for TW Cru from various sources

Dvorak (2004a), using ASAS-3 data stated that both minima were the same depth, but in fact my data showed that the primary was 0.05 magnitudes deeper than the secondary (Figure 1). The original photographic data of Bruna were not sufficient to determine whether there was a difference in magnitudes between primary and secondary; the ASAS data used by Dvorak were too noisy to separate primary and secondary minima within +/- 0.1 magnitude. Therefore, I tried adding half a period to the original GCVS epoch, on the assumption that it was based on a secondary minimum; the result was a better fit to the O – C data (Table 2).

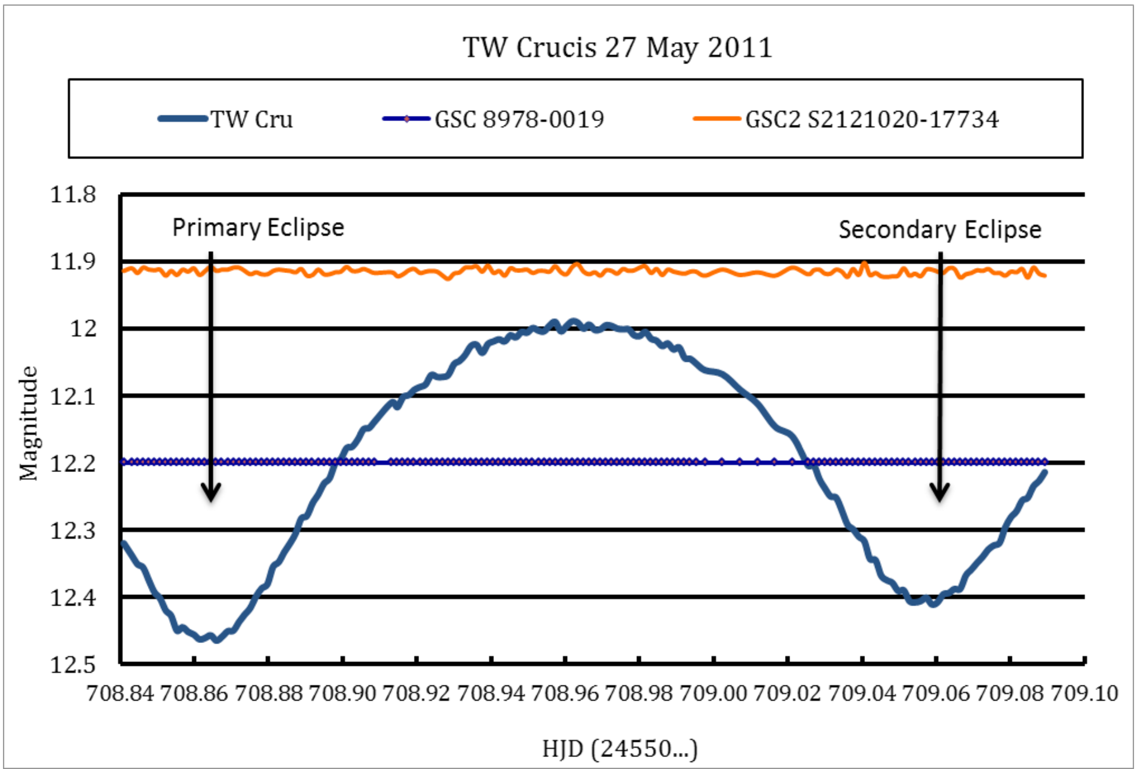


Figure 1. TW Crucis, showing the range of a primary and secondary eclipses

When my full set of data was entered into the Vstar programme (AAVSO), the resulting phase plot (Figure 2) indicated that the period was 0.388143 and epoch 2453106.753 (ie the epoch used by Dvorak 2004a). With these updated elements, my data agree to within a few minutes of the calculated times (Table 2).

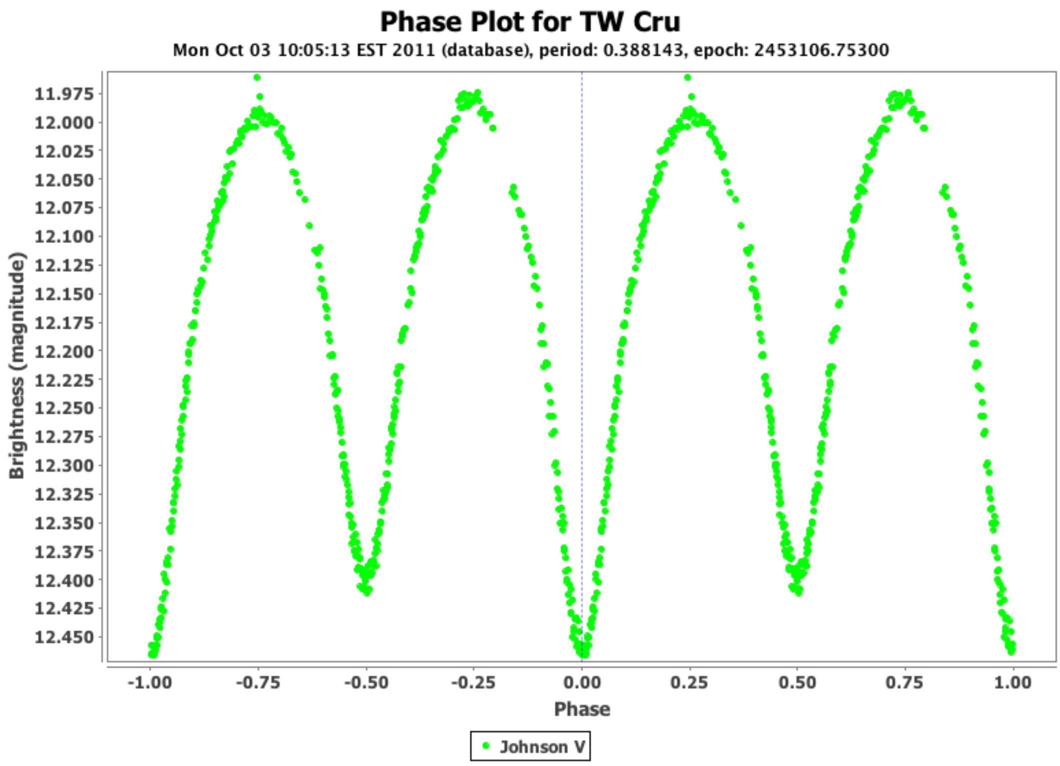


Figure 2. Vstar phase diagram for TW Crucis data of 2011-5-5 to 2011-7-4.

Equipment

Telescope: Celestron 280 mm Schmidt-Cassegrain (C11) with focal reducer: F6.8. Camera: SBIG ST8XME Kodak KAF1603ME NABG with Johnson-Cousins U,B,V, Rc & Ic filter set (Astrodon). Robofocus focus controller. Light box with 8 white LEDs for flat field corrections. Observatory: Sirius with Losmandy G11 mount at 315 Main Road, Wellington Point, Qld (at sea level).

Computer: Macbook Pro (in the observatory) and iMac 27" desk top, both Intel quad core and running Windows 7 in a Bootcamp partition.

Software: Windows 7; MaximDL Pro suite 5.15; Voyager 4.5 (planetarium programme for both Mac and Windows OS); Pinpoint full license (astrometry for locating stars in dense fields); FocusMax.

Timing: in MaximDL, the "Shutter Latency Measurement" tool was used to fix the time delay that occurs between the instant a command is issued to start an exposure and the instant at which the shutter actually opens, to the nearest 100th of a second (± 0.02 s for my ST8XME). The 1st Atomic Time v3.0 (from http://www.greenparrots.com) is claimed to keep the computer's clock accurate to 20ms in SNTP mode. I used it with the time server ntp1.cs.mu.OZ.au hosted at the University of Melbourne.

Acknowledgement

I wish to thank Tom Richards for his very helpful guidance and encouragement during the past year.

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BL Tel - Revisited — *Col Bembrick*

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Introduction

In the May VSS Newsletter Bembrick & Ainsworth (2011) presented a summary of CCD observations of BL Tel in year 2000 and Williams (2011a) announced the current (2011) observing programme and took on the role of co-ordinator. In the August Newsletter Williams (2011b) has analysed and summarised the current observations - both visual and CCD results.

This note reviews the current CCD observations - by Terry Bohlsen and Neil Butterworth - and compares them with the previous data – both visual and photometric. An attempt is made to further refine the period of BL Tel and to extend this refined period backwards to other photoelectrically determined Times of Minima (ToM).

Some Background

A brief literature survey is summarised here to highlight some interesting features of this long period eclipsing system. The primary is an early F-type supergiant with Teff of 6700K (Sasselov, 1984), while the secondary is probably a cool supergiant, filling its Roche lobe to the inner Lagrangian point. The Teff of the secondary is <3100K (Feast, 1967). The secondary has been and is still losing mass (see later section on 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 P1 = 65 days and P2 = 73 days (Sasselov, 1984). The orbital inclination, i = 90.0, and relative radii, R2 = 0.84R1, with masses M1 = 20 solar, M2 = 7 solar (Feast, 1967).

Picking the ToM in 2011

Visual and CCD data were acquired during the 2011 total eclipse. For the purposes of this paper the CCD data (in V and B) of Bohlsen and Butterworth (as provided by Williams) have been used. The light curves in both bandpasses (see Figure 1) are essentially identical as to shape and the definition of the “flat bottomed” minimum. The B-V value at total eclipse is approx 0.6, showing that the system is slightly redder during eclipse (the Johnson B-V is quoted as 0.523). Unfortunately, no out-of-eclipse data were obtained in V or B in 2011.

The flat bottomed term is in quotes because there are only a small number of data points in those parts of the curves to define the flat bottom. The bottom in fact has some slope or asymmetry in both the V and B data. Given the small number of data points that define this portion of the curves, it is assumed for the present that this is due to noise in the data. This effect does not appear in the year 2000 eclipse data of Bembrick & Ainsworth (2011), where the density of data points is slightly higher and a flat-bottomed portion of the light curve can be identified. The maximum time of totality for 2011 is 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 primary pulsations – mentioned previously.

It is interesting to note that there is essentially negligible asymmetry in the ascending and descending branches of these curves, although some small asymmetry has been reported in the past - both in CCD light curves (Bembrick & Ainsworth, 2011) and in the visual data (Williams, 2011b, 2002). This 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.

The ToM for the 2011 eclipse has been estimated from the CCD data by three methods – Peranso, Excel spreadsheet and manual plot measurement. Peranso will fit a polynomial to the light curve and produce a value for the extremum. However, the 6th order polynomial is not a good fit to the bottom part of the curve, due in part to the localised asymmetry. Peranso does fit higher order polynomialss but these do not yield a value for the extremum. In any case the higher order fit is skewed by the asymmetry and thus would produce an unreliable estimate of the ToM. The stated error by the Peranso 6th order fit is ±1.23 days, which seems way too high. A similar high error is quoted by the Kwee-van Woerden algorithm in Peranso.

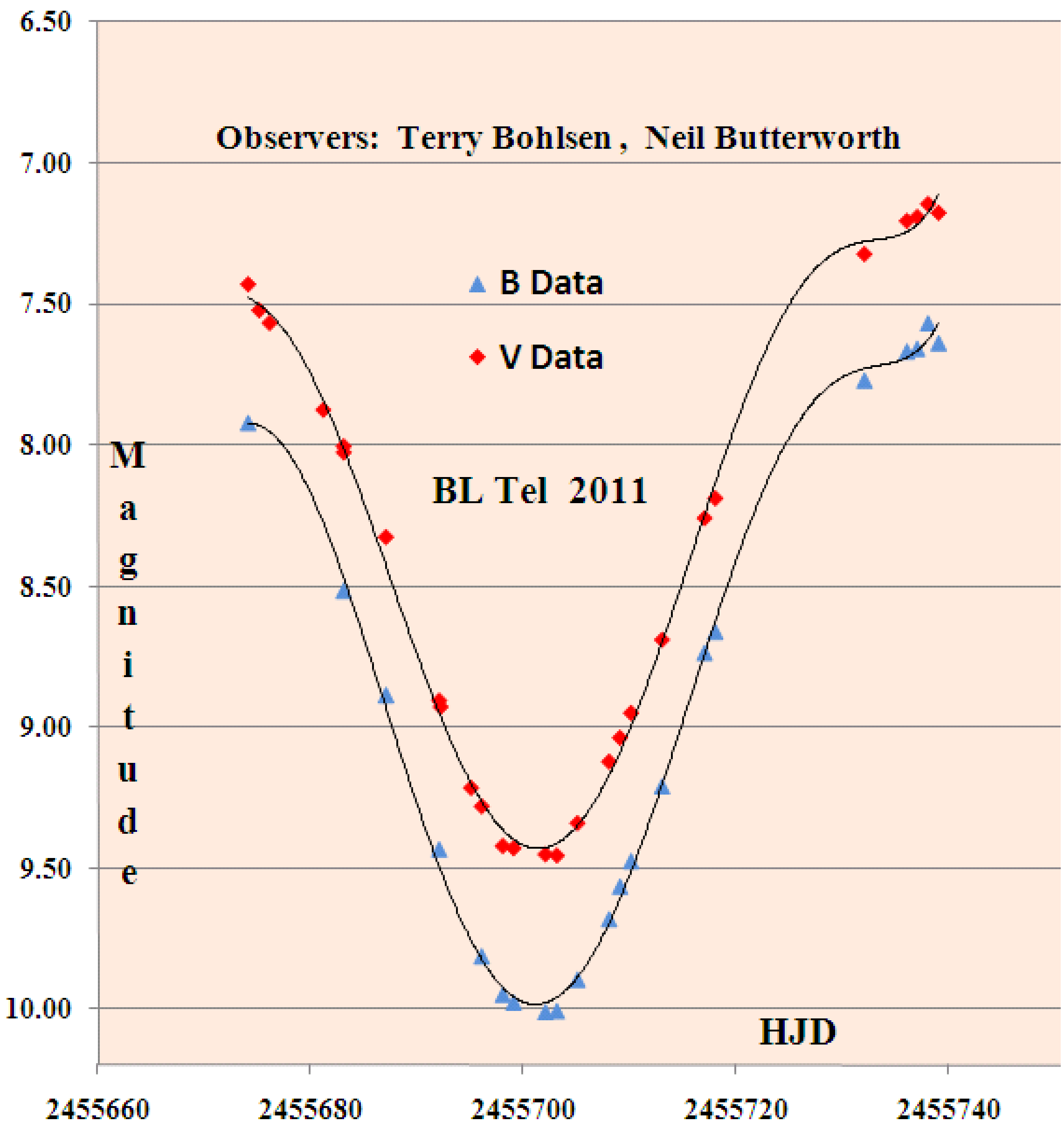

Figure 1. V and B light Curves of Primary Eclipse in 2011.

The Excel plot can be fitted with a 6th order polynomial and the ToM estimated by inspecting the curve in detail and measuring the scale. The errors here were estimated as ± 0.5 days. An Excel plot without the curve fit and using an expanded scale gives a ToM with estimated errors of ± 0.35 days. This would seem a more appropriate value of the error.

In summary, the ToM for 2011 has been taken as HJD 2455701.16 ± 0.35 days.

Plotting the O-C

The O-C values of a set of observations refer to the Observed minus the Calculated values, where the calculated values are obtained by the use of some ephemeris or light elements. These are often just tabulated, eg Bembrick & Ainsworth (2011) and Williams (2011b), where they can be inspected by eye and evaluated as to their scatter and extremes. However, it is often useful to graphically plot the O-C values against time (JD or cycle number). The inferences that can be made from this approach are briefly outlined by Cooper & Walker (1989) and are used in the discussion that follows. See also the treatment by Willson, 1986.

An O-C plot usually has the time along the x-axis and the O-C values on the y-axis. If the correct periodicity has been chosen, then the plot is a horizontal straight line with some scatter of individual O-C values above and below the line. If the period is slowly changing, then the plot exhibits a curve, which may be an upward or downward curve, depending on an increase or decrease in the period.

However, if the period chosen to fit the data is too short, then the straight line plot slopes upwards. Conversely, if the period chosen is too long, the straight line slopes downwards. In Figure 2 the BL Tel data for 1983 to 2011 are plotted using a period of 777.53 days (as in Bembrick & Ainsworth, 2011). Clearly, the period chosen is too short.

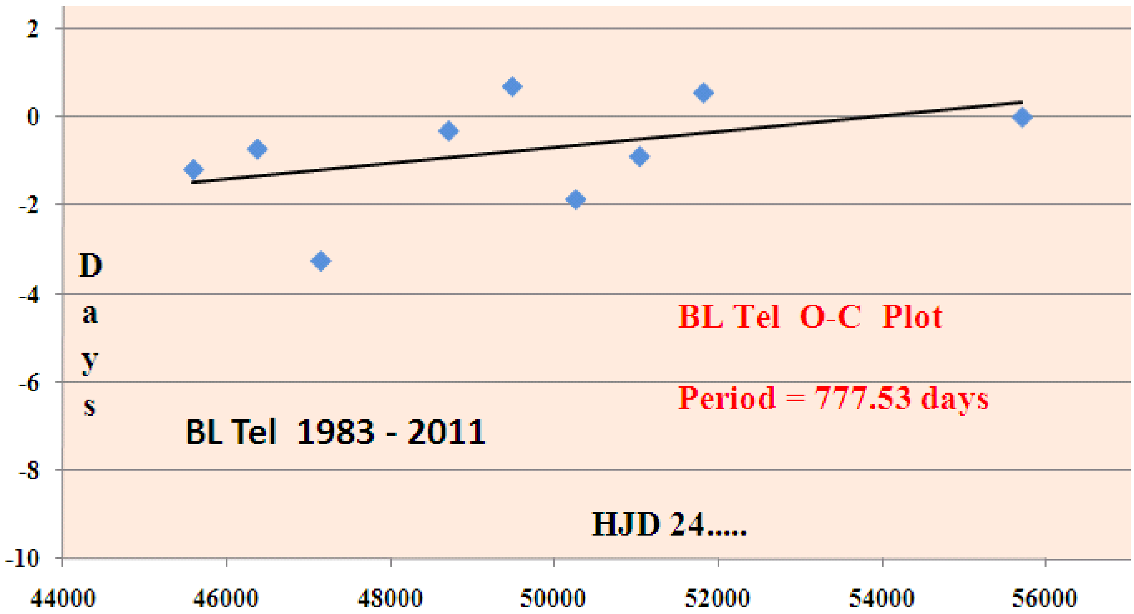

Figure 2. With P = 777.53 days (as in B & A, 2011) the O-C plot is rising, indicating that this P is too short.

In Figure 3, the same data are plotted with a period of 777.73 days (as in Williams, 2011b). Clearly, the period chosen is too long. Note how sensitive the plot is to these small changes in chosen period.

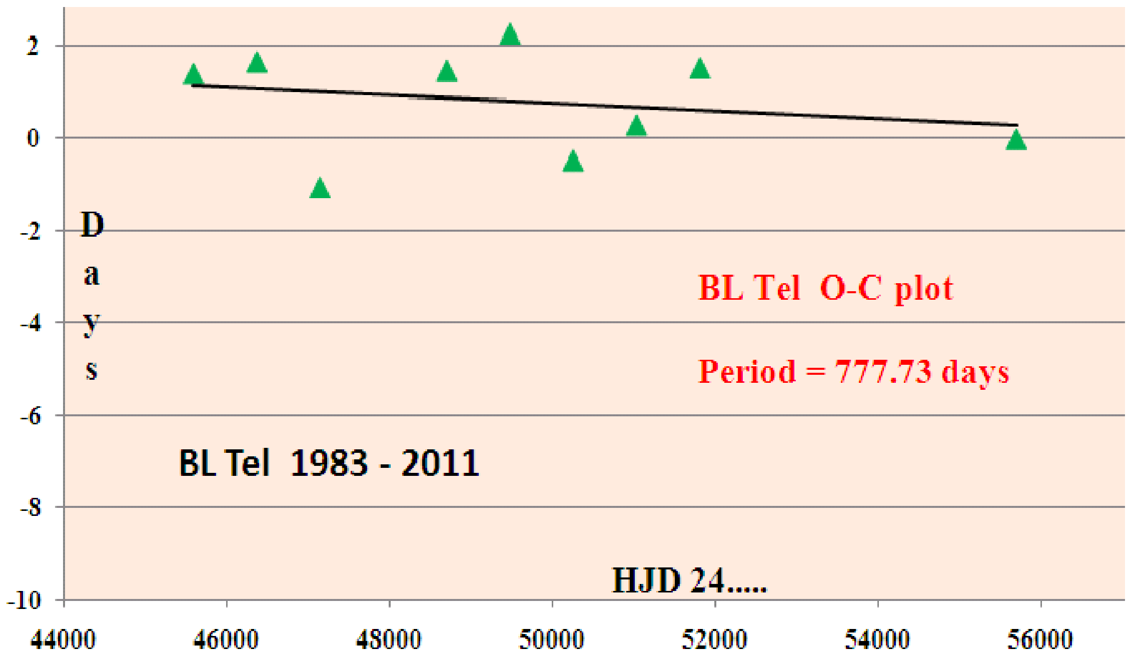

Figure 3. With P = 777.73 (Williams, 2011b) the O-C plot is falling, indicating that this P is too long.

By trial and error adjustment of the chosen period, the plot of Figure 4 is derived, showing a horizontal straight line. Thus the period of 777.693 days is the best fit to this data set. This value can be further refined by extending the data series to earlier ToM - see below.

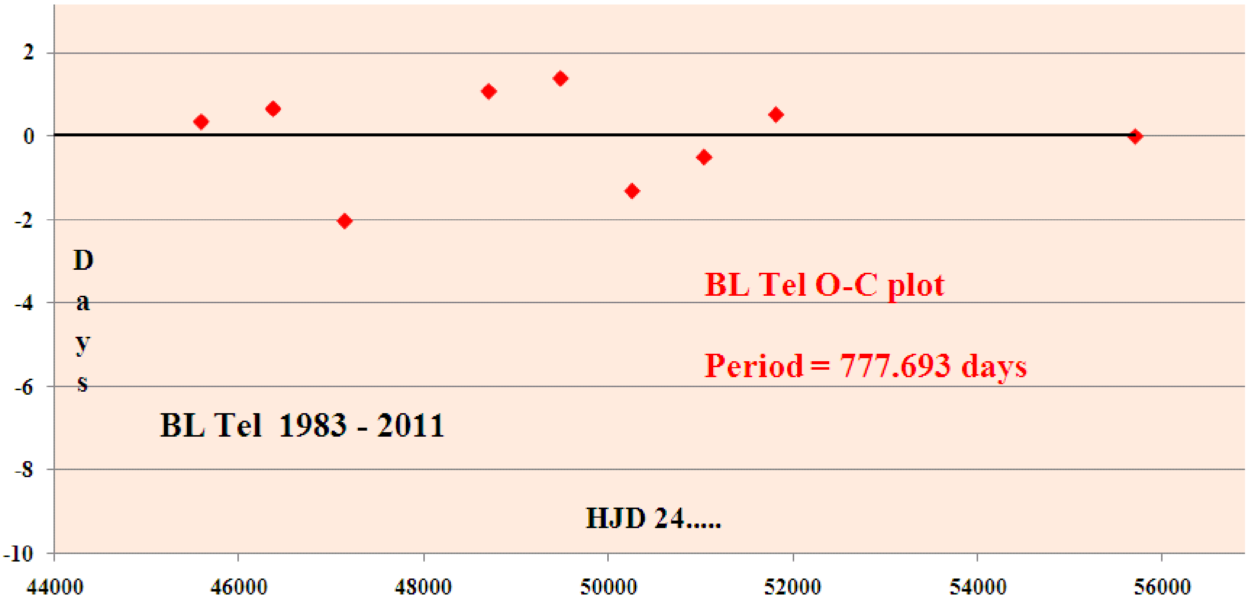

Figure 4. With a refined P = 777.693, the O-C plot is horizontal indicating this is the best estimate of P.

Deriving a refined period

The value of the period derived from trial and error manipulation of the O-C plot, using the ToM from 1977 to 2011 (Figure 5) was then used to compile Table 1.

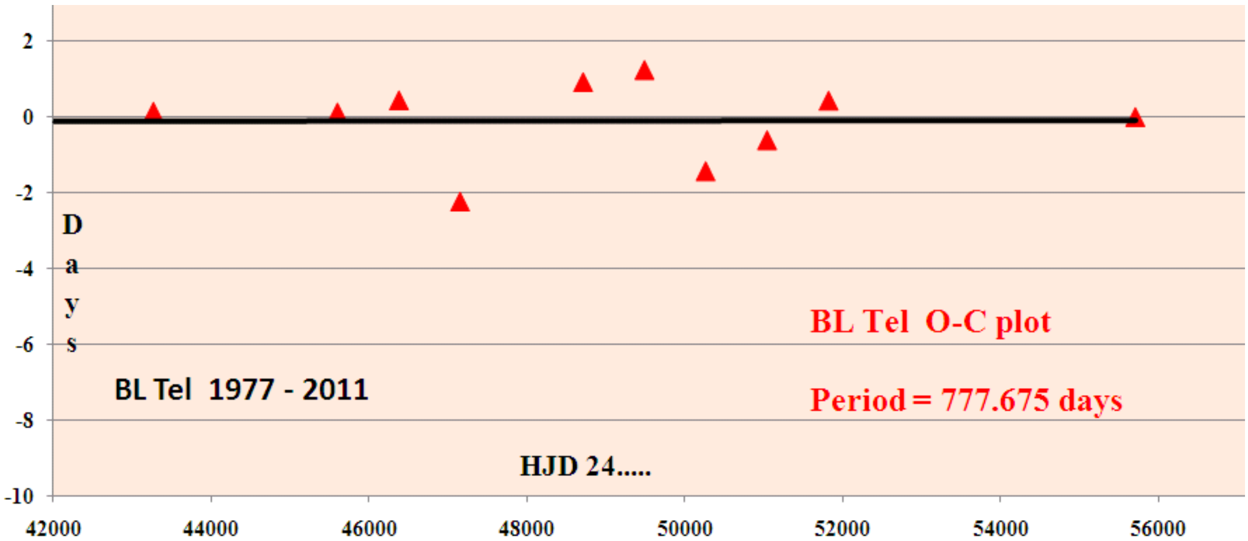

Figure 5. With added data back to 1977, the P can be further refined to P =777.675 days (note residuals RMS = 1.06 days)

Table 1 overleaf summarises the data over that period, which comprises only 16 cycles of this long period eclipsing system.

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

Table 1. O-C values using new CCD epoch in 2011 and a refined period = 777.675 days.

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

Note that the O-C values are satisfyingly small in almost all cases, the exception being the visual ToM in 1987. This is a useful comparison of the visual and CCD timings as only three of the tabulated values are CCD/photoelectric – 1977, 2000 and 2011 – the rest being visual. It illustrates the highly valuable data provided by the visual observers.

Fitting older photoelectric data

Following a brief literature survey, some older quoted values of ToMs were discovered (van Genderen, 1986), which were determined by photoelectric means. These results go back to 1953 (Cousins & Feast, 1954) and an attempt was made to fit these to the O-C plot using the refined period. The plot (Figure 6) clearly shows that this is not possible as the departures from the horizontal line are large and dramatic. Fitting a curve of some sort (indicating a gradually changing period) to this plot is probably more realistic than invoking an abrupt period change.

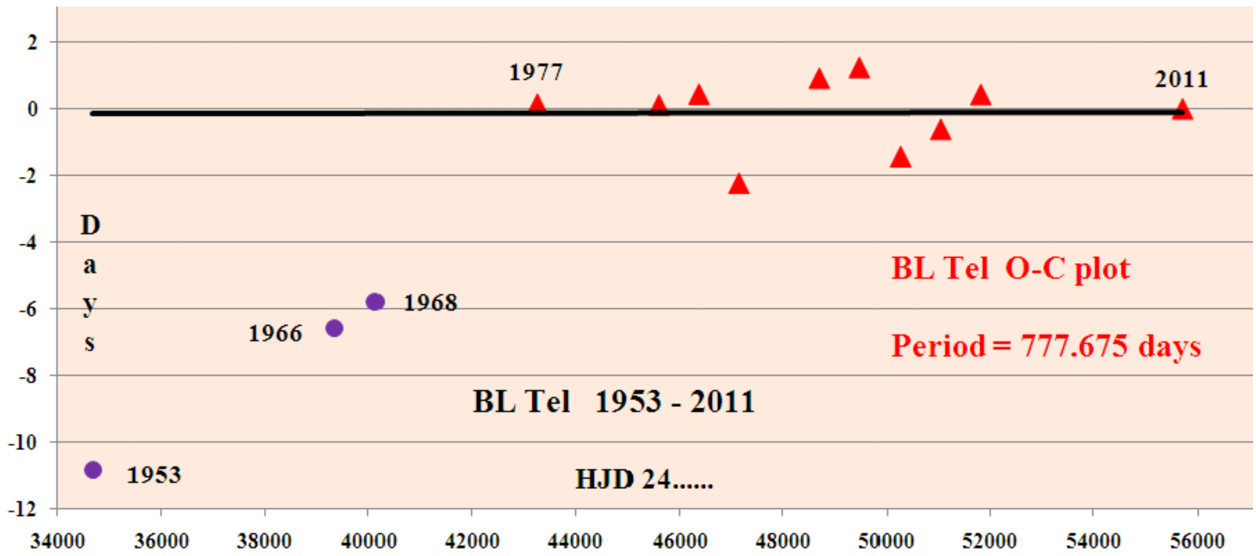

Figure 6. With data back to 1953, the early ToMs do not fit, suggesting a period change between 1968 & 1977.

Possible period change

Various values, ranging from 778 to 778.6 days, are quoted in the literature and Williams (2011b) quotes the catalogue value of 778.1 days. The tabulated O-C values of Williams (2011b) indicate that this latter period is less than satisfactory in its fit to the modern data. However, the minima of 1953, 1966 and 1968, covering 7 cycles of the system, yield a mean period of 778.41 days, which is within the range of values found in the literature.

The data of Figure 6 appear to indicate an abrupt period change in this eclipsing system sometime between the minima of 1968 and 1977. A mechanism for this change over this relatively short timespan would presumably involve mass loss/transfer between the components of the system. Such a mechanism is unlikely to operate in an abrupt manner, so a gradual (constant) period change is more plausible astrophysically. Consequently, an attempt was made to fit a quadratic regression to the data of Figure 6. This yielded a curve of best fit with the equation

y = -4.440E-08x2 + 1.436E-03x – 11.221 where y is O-C in days and x is HJD

The coefficients have been derived from the Peranso curve fit algorithm. This fitted curve is shown below in Figure 7.

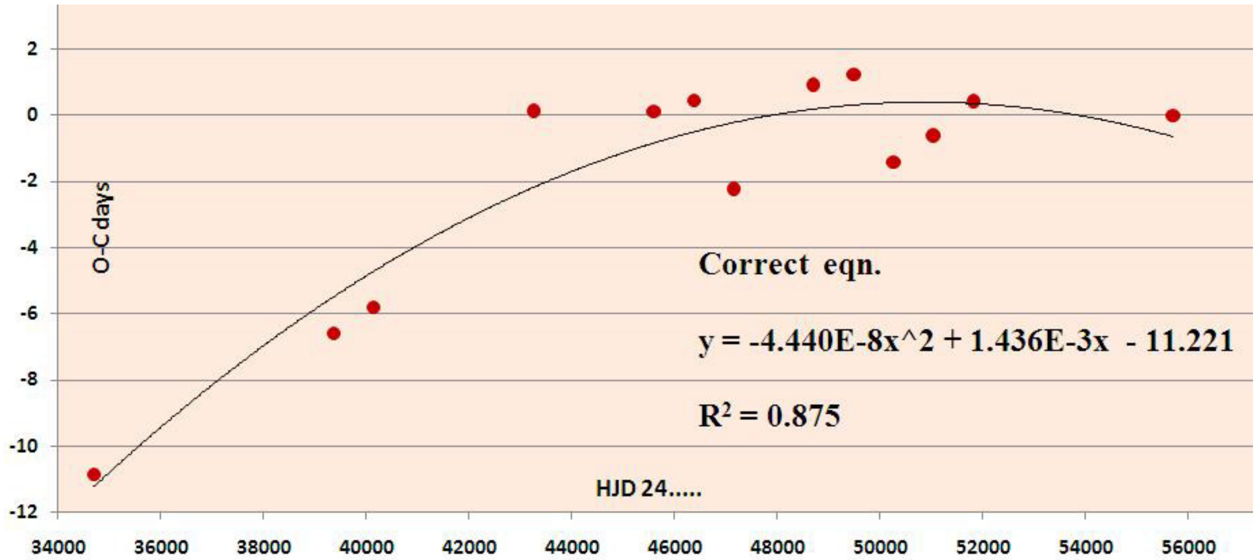

Figure 7. ToMs from 1953 to 2011with quadratic regression fit – ie with P decreasing at a constant rate of 0.18 sec/century.

The parabolic fit to the data in Figure 7 is not too bad, with an R^2 value of 0.87 (R^2 = 1 is a perfect fit). By comparison, a straight line fit to the above data yields an R^2 value of 0.67 – clearly much poorer. (The R^2 value is a type of correlation coefficient provided by Excel). More conventionally, the RMS deviation of the residuals for the above data is 1.21 – not significantly worse than the straight line fit to the restricted data set of Figure 5 – where it was 1.06. It should be noted that van Genderen (1986) is of the opinion that the eclipses of 1968 and 1977 have “not too well observed times” of primary eclipse minima. If these (the third and fourth values from the left) are omitted from the above plot, then an R^2 value of 0.9 is achieved.

The changing period implied by the above fitted curve suggests that mass transfer is still occurring, as mentioned in the literature. This is clearly a very interesting binary system, about which we have much to learn, and further study is certainly warranted.

Further investigations

A search for additional ToM data will be undertaken, particularly in the interval 1968 and 1977 – either visual or photoelectric data would be critical here. Note that the eclipses between the minima of 1953 and 1962 were unobservable as these events occurred essentially in daylight. This system could be used as an exercise in modelling with Binary Maker 3.0. I might put that on my to do list.

Conclusions

Using the newly determined (CCD) ToM for 2011, combined with the refined period quoted above, the new (linear) light elements proposed here are:-

HJD 2455701.16 ± 0.35 + 777. 675 ± 0.17 X E, where E is the cycle no. or Epoch.

This eclipsing binary may have undergone a period change sometime between the observed minima of 1968 and 1977. Prior to 1977 the mean period is 778.41 days, as opposed to the value presented here of 777.675 days. This represents a change of 0.735 days. However, a gradual (constant) rate of period change also fits the data, as shown in Figure 7, and this may be a more realistic and astrophysically plausible interpretation of the data.

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. Given the binary RA of 19hr, this should be an eclipse that is well observed.

Acknowledgements

Peter Williams is thanked for his timely analysis of the 2011 data and for passing on the CCD plots and data. Terry and Neil are thanked for their efforts in obtaining the valuable two-colour CCD data for BL Tel in 2011. Tom Richards is warmly thanked for his highly useful comments, which much improved the manuscript.

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EEB Project— SZ Piscium – *Margaret Streamer*

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The eclipsing binary system, SZ Piscium, has been on the EEB project list for a couple of years but so far nobody has sent in any results. However, SZ Psc (RA 23:13:23.79, Dec +02:40:31.6) is an important, bright, eclipsing binary that is much in need of photometric monitoring.

One problem could be the period (3.965694days) – just under 4 days, which means that suitable eclipse times only occur about every 3 months. Couple this with bad weather and the inevitable, unavoidable motion of our planet around the sun, and the windows of opportunity to observe an eclipse become few.

A second problem could be the brightness of the system – Vmag 7.2 at maximum, dropping to 7.7 at primary eclipse. Some observers might have difficulty handling this magnitude, but maybe this project would be a good one for those with DSLRs.

But don't let all this put you off. SZ Psc is an interesting system that deserves attention and monitoring in the long term and during the out-of-eclipse phases.

SZ Psc belongs to the RS Canum Venaticorum stars defined as binary stars having a hotter component F-G IV-V, with strong H and K emission lines seen in the spectrum outside of eclipse (Ref 1). They also show unusual photometric variability and other exotic properties such as radio emission and flaring, thermal X-ray emission and other elemental emission. These properties are interpreted as starspots, a thick chromosphere and coronal magnetic loops. Like our sun but with energy scales two to three orders of magnitude larger.

In the case of SZ Psc, there is a spotted, chromospherically active K1 subgiant and a much less luminous, inactive F5 IV star. Recent spectroscopy has established that the system is in fact a triple system with the third body likely to be a cool dwarf with mass similar to our sun and contributing about 5% of the light in V (Ref 2). The period of the entire system is in the region of 1000-1500 days.

Optical light curves for SZ Psc show a distinctive modulation outside of the eclipse which is attributed to cool starspots with the variation of spot location and size being the main reason for the changing shape of light curves. Eclipsing systems are particularly suited to modelling the surface distribution of the spots over time and give information on active longitudes and activity cycles (Ref 3). Percy (Ref 1) discusses the out-of-eclipse photometric variability in the form of an approximate sinusoidal distortion wave in more detail.

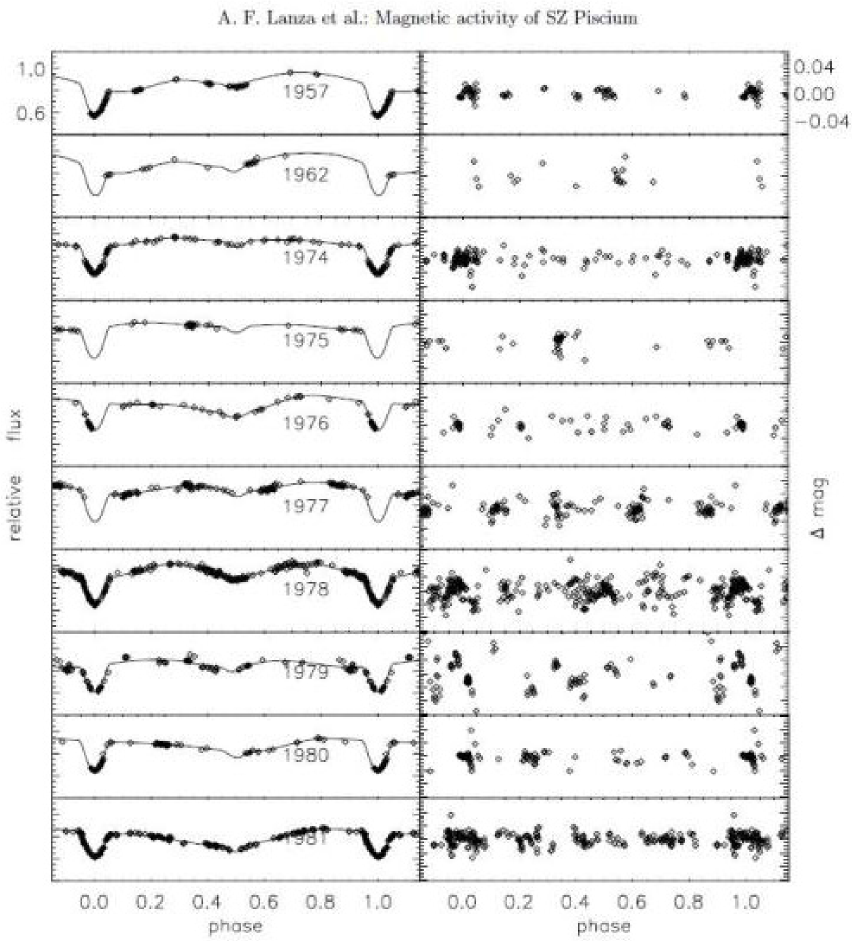

Fig 1. V-band light curve fits from 1987 to 1981 in the left panel with corresponding residuals in the right panel. The right panel scale is about six times more expanded than the left panel scale. From ref 3.

Figure 1, which is taken from reference 3, clearly shows the distortion waves in SZ Psc.

The more luminous and larger secondary component has three active longitudes. There are sizeable fluctuations showing a possible 13-year cycle and a possible non-sinusoidal, longer 30-year cycle. Changes in spot numbers are also responsible for an overall dimming or brightening of the system.

Lanza et al (Ref 3) also suggest a possible connection between magnetic activity and an observed orbital period variation. There is a sinusoidal variation in its O-C curve with a period of about 60 years. However the time span of the available data was not long enough for any definite conclusions to be drawn (see Fig 2).

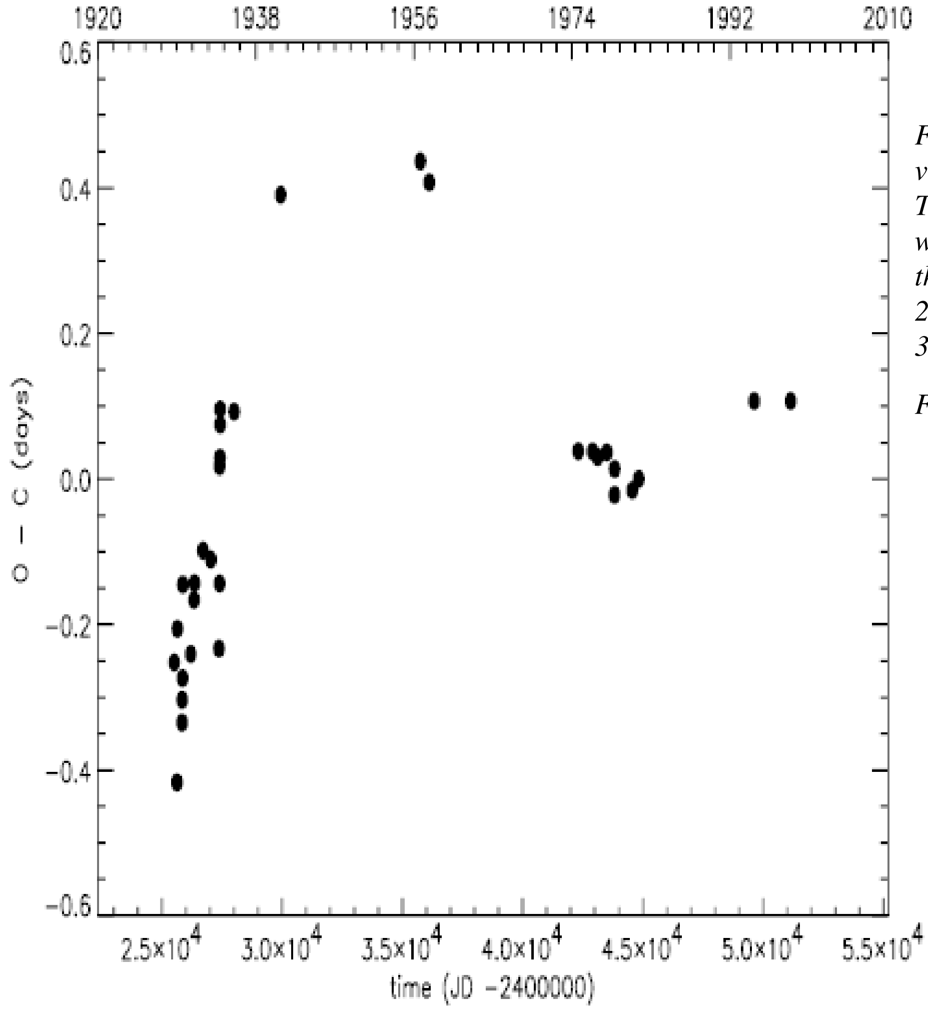

Fig 2. Orbital period variations of SZ Psc vs Time. The O - C residuals were computed adopting the ephemeris Min I = 2444827.0047 + 3.9657889 x E.

From ref 3.

There is a real opportunity here for amateur observers to contribute photometric data on this system for future access by professionals as there have been numerous studies on this system which rely on available photometric results. Both in- and out-of-eclipse observations would be useful additions to the data bank.

The next opportunity to observe eclipses is in December – see table below, although observers in Australia and New Zealand probably won't be able to observe the early morning eclipses. But in the mean time, don't forget some out-of-eclipse observations. My own results (one very short time series out-of-eclipse) suggest that the system is a little dim at the moment (Vmag ~7.5, untransformed) compared to the usual Vmag 7.2.

Tom Richards has suggested that anybody interested in observing this system, register their interest with me (email: m.stream@bigpond.com) and I'll send you information on the system. We'll try for filtered observations in V initially and transformed magnitudes would be best but untransformed ones will be acceptable. The usual EEB observing/reporting guidelines apply (see the VSS website for this information).

Primary Minimum				Secondary Min			
Epoch	ToM HJD	UT date	UT time	Epoch	ToM HJD	UT date	UT time
857	2455899.199758	2011-12-03	16:47:39	857	2455901.183	2011-12-05	16:22:57
858	2455903.165452	2011-12-07	15:58:15	858	2455905.148	2011-12-09	15:33:33
859	2455907.131146	2011-12-11	15:08:51	859	2455909.114	2011-12-13	14:44:09
860	2455911.096840	2011-12-15	14:19:27	860	2455913.08	2011-12-17	13:54:45
861	2455915.062534	2011-12-19	13:30:03	861	2455917.045	2011-12-21	13:05:21
862	2455919.028228	2011-12-23	12:40:39	862	2455921.011	2011-12-25	12:15:57
863	2455922.993922	2011-12-27	11:51:15	863	2455924.977	2011-12-29	11:26:33
864	2455926.959616	2011-12-31	11:01:51				
865	2455930.925310	2012-01-04	10:12:27				

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VStar Overview – *David Benn*

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The development of VStar came about as the result of a conversation at NACAA 2008 with AAVSO Director Arne Henden. Apart from giving a keynote address, Arne convened a session titled “How can you help the AAVSO?” During a break, I approached him and asked whether AAVSO had any software projects in need of a developer. He mentioned that there existed a DOS program called VSTAR that was in need of being rewritten and expanded as a modern cross-platform application.

Tom Richards joined the conversation, commenting (as I recall) that if such an open source tool were developed, he would appreciate features such as pre-whitening (subtracting a period search derived model from a dataset in order to look for additional signal), CLEANest for multi-period analysis, and WWZ for analysis of change in period over time.

Grant Foster’s DOS VSTAR program was used in the context of AAVSO’s “Hands on Astrophysics” tutorial material, subsequently updated and renamed “Variable Star Astronomy”. This, along with the Citizen Sky project, formed the backdrop of VStar development.

It was decided that the new VStar incarnation would be a multi-platform, desktop application written in the Java programming language, and that it would be made available under the GNU Public License. This meant that anyone could obtain the source code and do whatever they wanted with it, so long as fixes and improvements were contributed back to the code base.

Requirements analysis, design, and coding began in May 2009 as a volunteer effort. AAVSO staff members and others associated with Citizen Sky have been generous with their time and knowledge.

The current formal release is version 2.12 and is available via the AAVSO and Citizen Sky web sites or from SourceForge. The features Tom expressed interest in at NACAA 2008 will appear in the next release that is currently under test. This pre-release version is the focus here, and is already available from the Citizen Sky VStar Team web forum (see Links).

A lot of water has passed under the bridge since the 2010 NACAA VStar workshop (from which came important feedback). The tool’s feature set has grown and some limitations have been lifted, eg the need to login just to access AAVSO International Database datasets has gone away. Login is only required if you wish to report discrepant observations to AAVSO (possible from VStar or Zapper now).

The remainder of this article gives an example-driven overview of the current state of VStar. Future articles will look at particular features in more depth.

Figure 1 shows the last two years of Johnson V band data (up to early November 2011) for the bright Cepheid variable X Sgr loaded by VStar from the AAVSO International Database (AID).

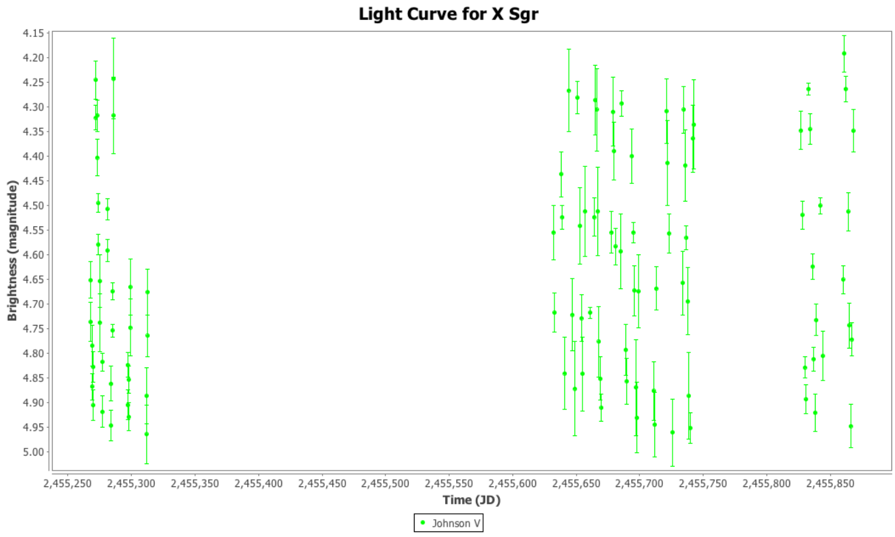


Figure 1. Last 2 years of X Sgr Johnson V data from AID.

In addition to AID, VStar can load data from files in AAVSO download format or a simpler format consisting (at minimum) of Julian Date and magnitude. VStar's plug-in architecture has allowed it to be extended with observation source plug-ins so that Kepler, SuperWASP, and AAVSO Upload Format files can be read. Once installed, these plug-ins appear as additional File menu items. Other observation source plug-ins are planned. Moreover, other plug-in types exist, more about which will be said in future articles.

Figure 2 shows a screenshot of the VStar program window and the same X Sgr dataset but with all loaded bands displayed on the plot.

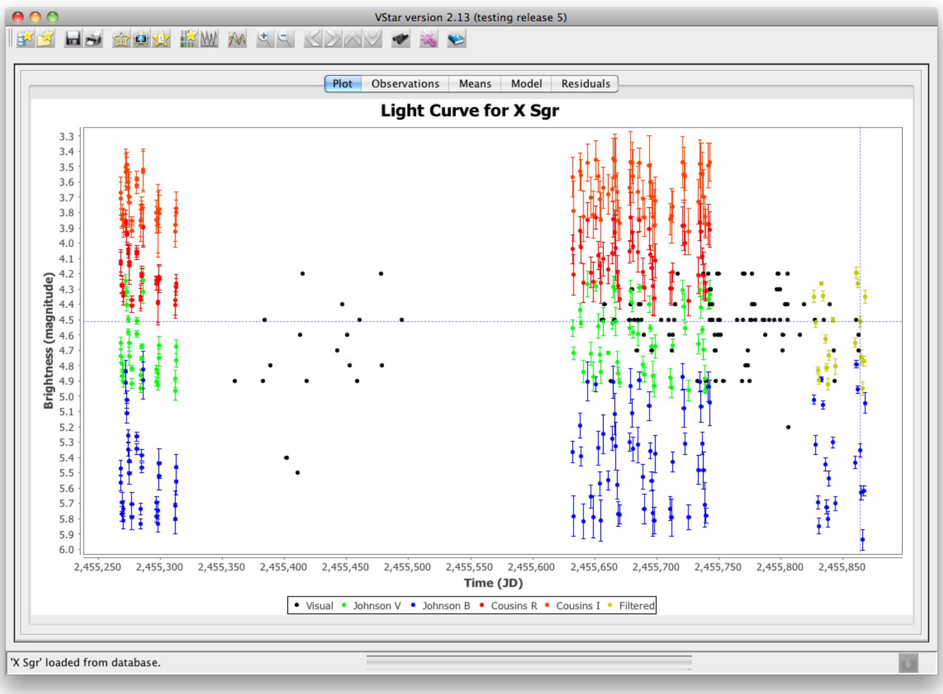
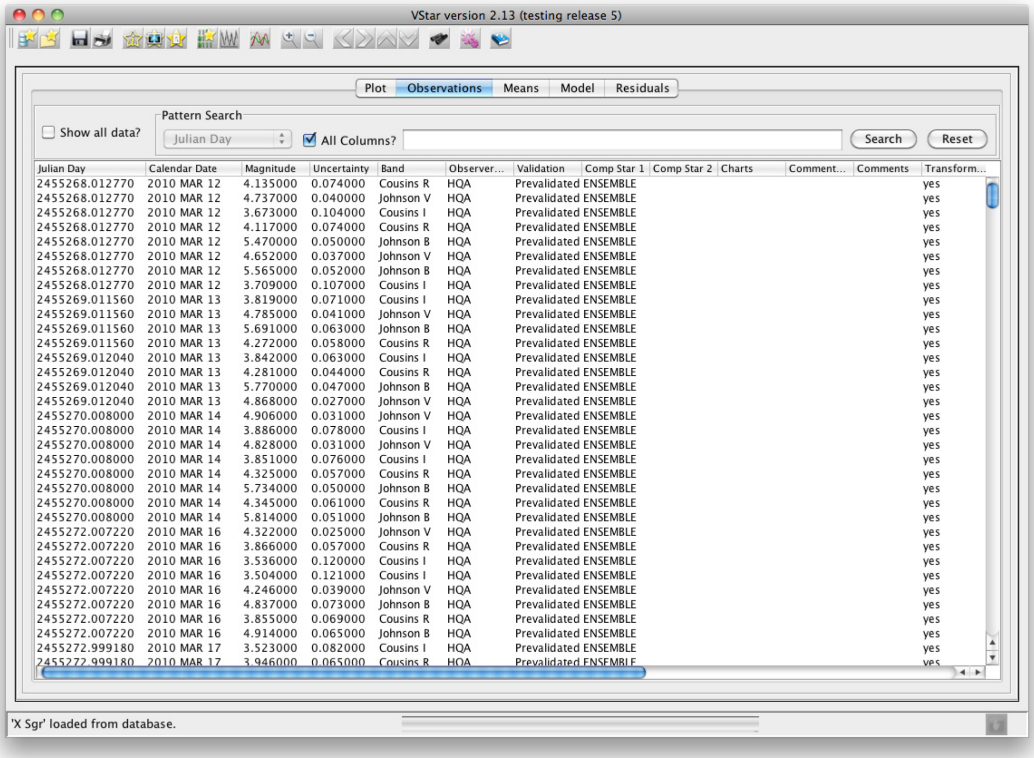


Figure 2. Screenshot of VStar showing a plot of all X Sgr bands.

The data shown on the plot can also be viewed in tabular form in the Observations tab, as shown in

Figure 3. Data can be re-ordered by column and searched with textual patterns (regular expressions). By default this table shows only what is visible on the plot but the "Show all data?" option and pattern search affect this.

Synthetic data such as binned means, polynomial fit, model or residuals data are not shown in the observations table. These are available via other tabbed panes that will be explored in future instalments.



Julian Day	Calendar Date	Magnitude	Uncertainty	Band	Observer...	Validation	Comp Star 1	Comp Star 2	Charts	Comment...	Comments	Transform...
2455268.012770	2010 MAR 12	4.135000	0.074000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes
2455268.012770	2010 MAR 12	4.737000	0.040000	Johnson V	HQA	Prevalidated	ENSEMBLE					yes
2455268.012770	2010 MAR 12	3.673000	0.104000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455268.012770	2010 MAR 12	4.117000	0.074000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes
2455268.012770	2010 MAR 12	5.470000	0.050000	Johnson B	HQA	Prevalidated	ENSEMBLE					yes
2455268.012770	2010 MAR 12	4.652000	0.037000	Johnson V	HQA	Prevalidated	ENSEMBLE					yes
2455268.012770	2010 MAR 12	5.565000	0.052000	Johnson B	HQA	Prevalidated	ENSEMBLE					yes
2455268.012770	2010 MAR 12	3.709000	0.107000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455269.011560	2010 MAR 13	3.819000	0.071000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455269.011560	2010 MAR 13	4.785000	0.041000	Johnson V	HQA	Prevalidated	ENSEMBLE					yes
2455269.011560	2010 MAR 13	5.691000	0.063000	Johnson B	HQA	Prevalidated	ENSEMBLE					yes
2455269.011560	2010 MAR 13	4.272000	0.058000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes
2455269.012040	2010 MAR 13	3.842000	0.063000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455269.012040	2010 MAR 13	4.281000	0.044000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes
2455269.012040	2010 MAR 13	5.770000	0.047000	Johnson B	HQA	Prevalidated	ENSEMBLE					yes
2455269.012040	2010 MAR 13	4.868000	0.027000	Johnson V	HQA	Prevalidated	ENSEMBLE					yes
2455270.008000	2010 MAR 14	4.906000	0.031000	Johnson V	HQA	Prevalidated	ENSEMBLE					yes
2455270.008000	2010 MAR 14	3.886000	0.078000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455270.008000	2010 MAR 14	4.828000	0.031000	Johnson V	HQA	Prevalidated	ENSEMBLE					yes
2455270.008000	2010 MAR 14	3.851000	0.076000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455270.008000	2010 MAR 14	4.325000	0.057000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes
2455270.008000	2010 MAR 14	5.734000	0.050000	Johnson B	HQA	Prevalidated	ENSEMBLE					yes
2455270.008000	2010 MAR 14	4.345000	0.061000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes
2455270.008000	2010 MAR 14	5.814000	0.051000	Johnson B	HQA	Prevalidated	ENSEMBLE					yes
2455272.007220	2010 MAR 16	4.322000	0.025000	Johnson V	HQA	Prevalidated	ENSEMBLE					yes
2455272.007220	2010 MAR 16	3.866000	0.057000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes
2455272.007220	2010 MAR 16	3.536000	0.120000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455272.007220	2010 MAR 16	3.504000	0.121000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455272.007220	2010 MAR 16	4.246000	0.039000	Johnson V	HQA	Prevalidated	ENSEMBLE					yes
2455272.007220	2010 MAR 16	4.837000	0.073000	Johnson B	HQA	Prevalidated	ENSEMBLE					yes
2455272.007220	2010 MAR 16	3.855000	0.069000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes
2455272.007220	2010 MAR 16	4.914000	0.065000	Johnson B	HQA	Prevalidated	ENSEMBLE					yes
2455272.999180	2010 MAR 17	3.523000	0.082000	Cousins I	HQA	Prevalidated	ENSEMBLE					yes
2455272.999180	2010 MAR 17	3.946000	0.065000	Cousins R	HQA	Prevalidated	ENSEMBLE					yes

Figure 3. The observation table for X Sgr.

Note that plots and tables can be saved to files (tab, comma, or space separated) and printed, including just the data in the table at the time.

Figure 4 shows an information window (Info… item in File menu or toolbar) for the loaded dataset. The anova (Analysis of Variance) value and other aspects of the information window will be covered in subsequent articles.

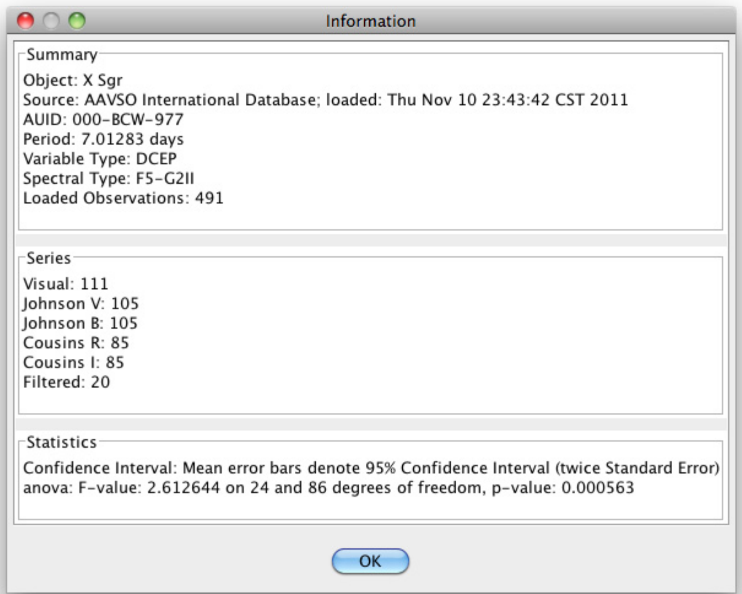


Figure 4. X Sgr information window.

The plot in Figure 2 shows the cross-hairs situated on a particular data point. Figure 5 is the details dialog obtained by choosing the View menu's Observation Details item for that selected data point. The same outcome can be achieved by selecting the corresponding row in the observations table (Figure 3) followed by the View menu item. In fact, the plot and table are synchronised with respect to observation selection.

The Plot Control View menu item (or equivalent toolbar button) shown in Figure 6 allows aspects of the plot to be changed, including what bands are visible on the plot, which series should be used as the basis for the binned mean series, the number of days per bin, whether error bars should be rendered, and so forth.

It should be noted that the preferences dialog can be used to customise the colour of each series.

As the plot control dialog shows, the Filtered series has been selected for display. In Figure 2, this series can be seen as a group of yellow observations near the right hand side of the plot. Figure 7 shows the dialog box that was used to create that series and alongside, the plot showing just the Johnson V data and the Filtered series. That observer code, as in Figure 5, belongs to a VSS member who recently submitted X Sgr and other bright Cepheid DSLR photometry data to AID.

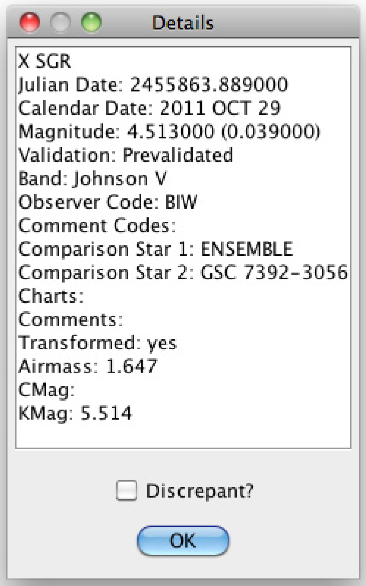


Figure 5. Observation details for selected X Sgr data point.

The filter requests all observations whose observer code is BIW (Neil Butterworth; mentioned with permission) and whose band is Johnson V. Without the band constraint, all of BIW's data would be included in the Filter series, such as the Johnson B band. If the filter had asked for all observations of X Sgr by the observer with code BDJB, a handful of visual estimates by the author would have been the result.

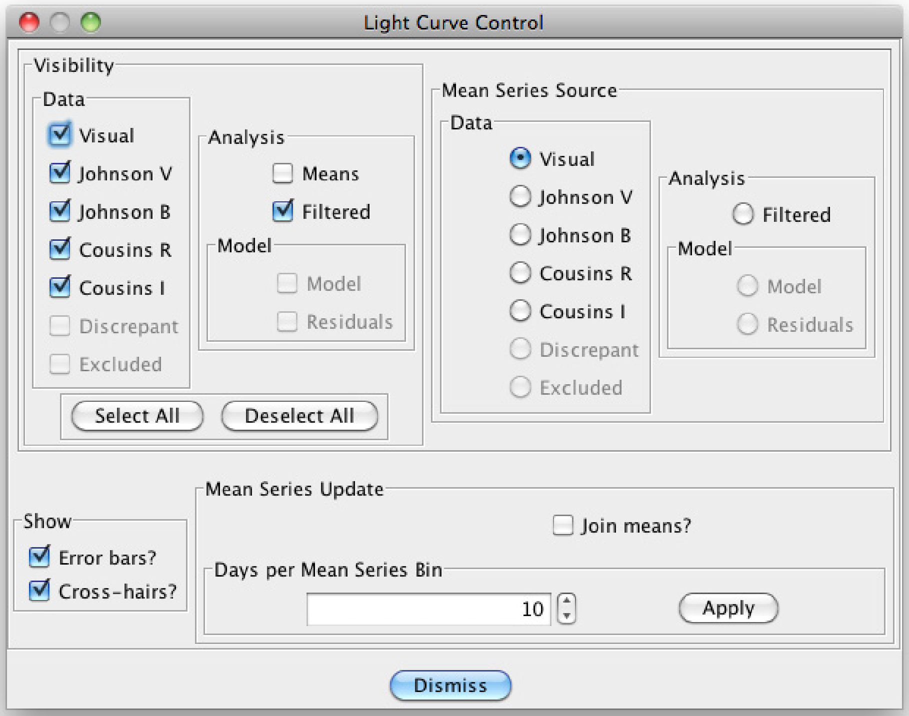


Figure 6. Plot Control dialog for the plot of Figure 2.

The filter mechanism is currently limited to conjunctive expressions, for example: A and B, not A and B. I intend to expand this expression language to permit more complex filters, such as: (A or B) and (C and not D), and to permit an arbitrary multiple row selection in the observation table to be converted into a Filter series.

Given that X Sgr has a published period of 7.01283 days, which VStar obtains from VSX for AID loaded datasets, a phase plot could be created via an Analysis menu item or corresponding toolbar button.

But what if this dataset had not been loaded from AID but instead from a file of observations for which VSX is not consulted? A period search item from the Analysis menu can be selected, such as DC DFT (Date Compensated Discrete Fourier Transform) Standard Scan.

Figure 8 shows the top-hits table resulting from a “DC DFT with Period Range” of the Johnson V series, with a minimum of 1 day, a maximum of 10 days, and a resolution of 0.001 days

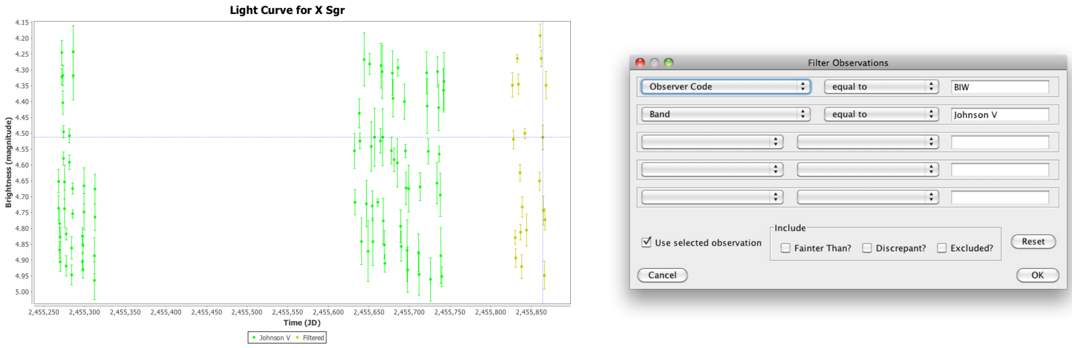


Figure 7. Filtered series creation dialog and plot with Johnson V and Filtered series.

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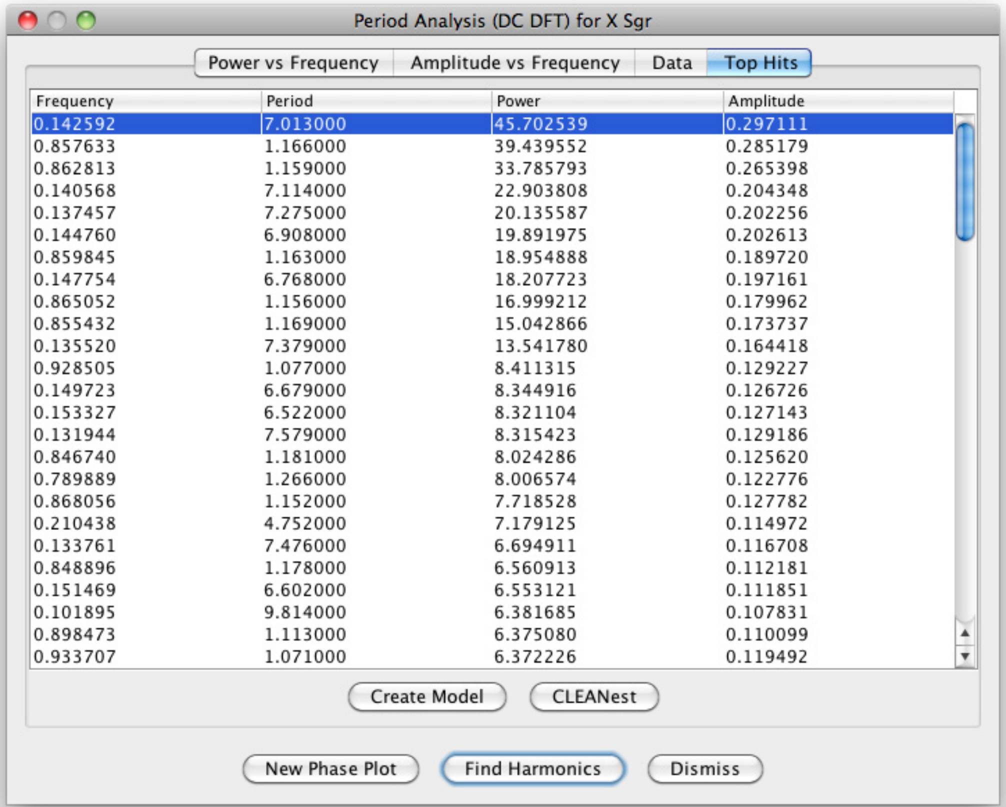

Frequency	Period	Power	Amplitude
0.142592	7.013000	45.702539	0.297111
0.857633	1.166000	39.439552	0.285179
0.862813	1.159000	33.785793	0.265398
0.140568	7.114000	22.903808	0.204348
0.137457	7.275000	20.135587	0.202256
0.144760	6.908000	19.891975	0.202613
0.859845	1.163000	18.954888	0.189720
0.147754	6.768000	18.207723	0.197161
0.865052	1.156000	16.999212	0.179962
0.855432	1.169000	15.042866	0.173737
0.135520	7.379000	13.541780	0.164418
0.928505	1.077000	8.411315	0.129227
0.149723	6.679000	8.344916	0.126726
0.153327	6.522000	8.321104	0.127143
0.131944	7.579000	8.315423	0.129186
0.846740	1.181000	8.024286	0.125620
0.789889	1.266000	8.006574	0.122776
0.868056	1.152000	7.718528	0.127782
0.210438	4.752000	7.179125	0.114972
0.133761	7.476000	6.694911	0.116708
0.848896	1.178000	6.560913	0.112181
0.151469	6.602000	6.553121	0.111851
0.101895	9.814000	6.381685	0.107831
0.898473	1.113000	6.375080	0.110099
0.933707	1.071000	6.372226	0.119492

Figure 8. Top-hits for DC DFT, V band, 1 to 10 days search range.

Figure 9 shows a small portion of the power spectrum (power vs frequency) plot from another tab in the results dialog. The frequency at the cross-hairs corresponds to the selected top-hits row of 0.142592 cycles per day or a period of 7.013 days (the reciprocal of the frequency), close to the 7.01283 days from VSX shown in the information window (Figure 4).

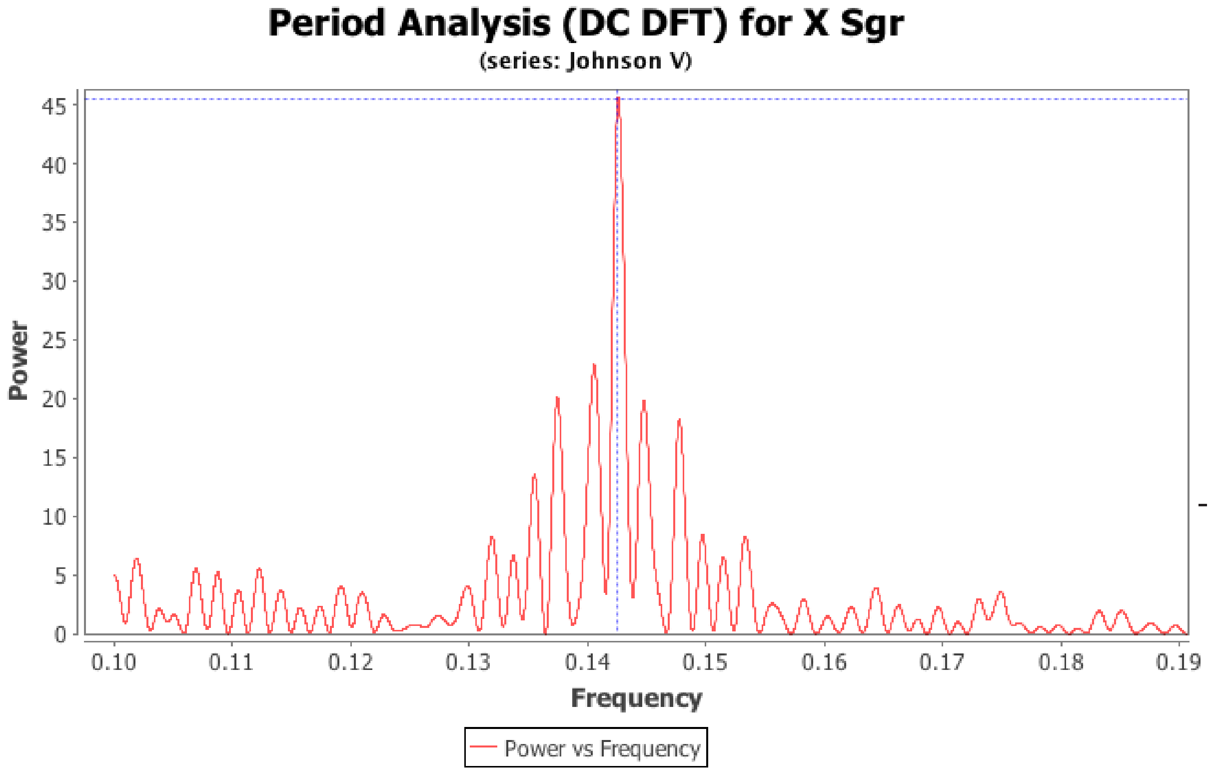

Figure 9. Power vs frequency for DC DFT, V band, 1 to 10 days search range.

Clicking the "New Phase Plot" button in the top-hits or data table pane yields the phase plot shown in Figure 10, showing the Johnson V and Filtered series.

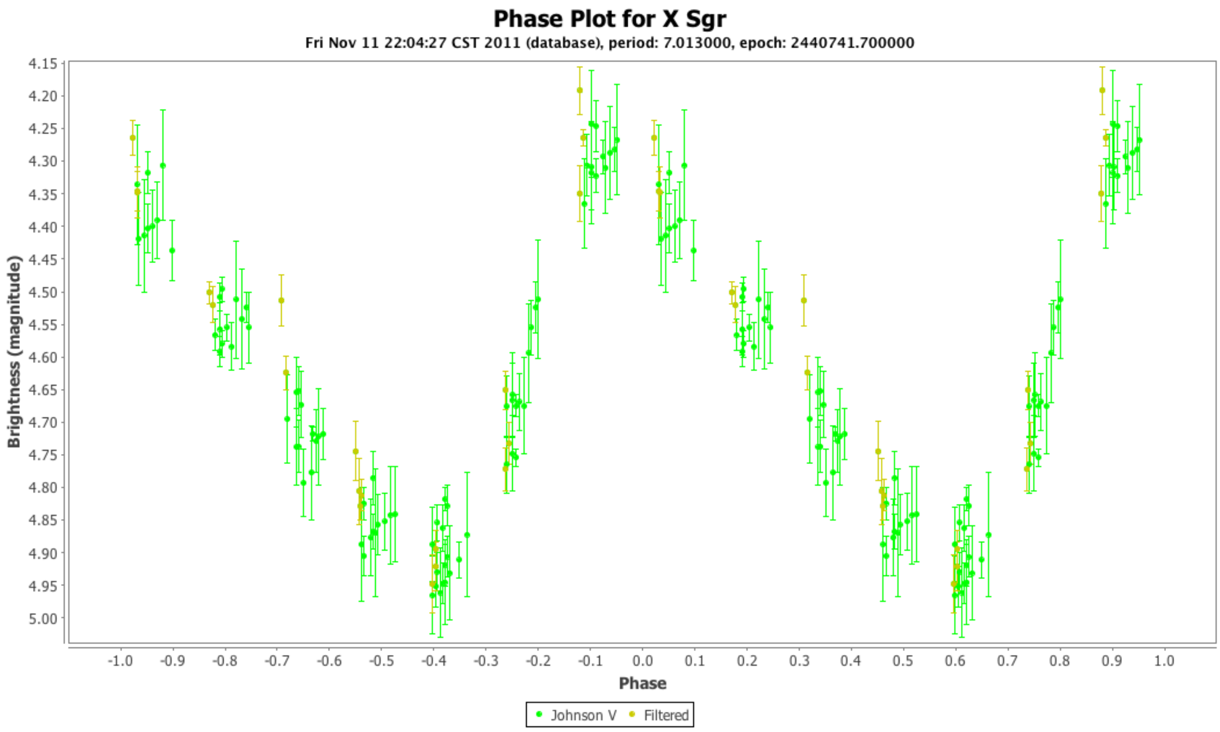

Figure 10. Phase plot with a period of 7.013 days for X Sgr.

Figure 11 shows the same phase plot as Figure 10, with the addition of a 3 harmonic model created via the “Create Model” button on the top-hits or data table pane.

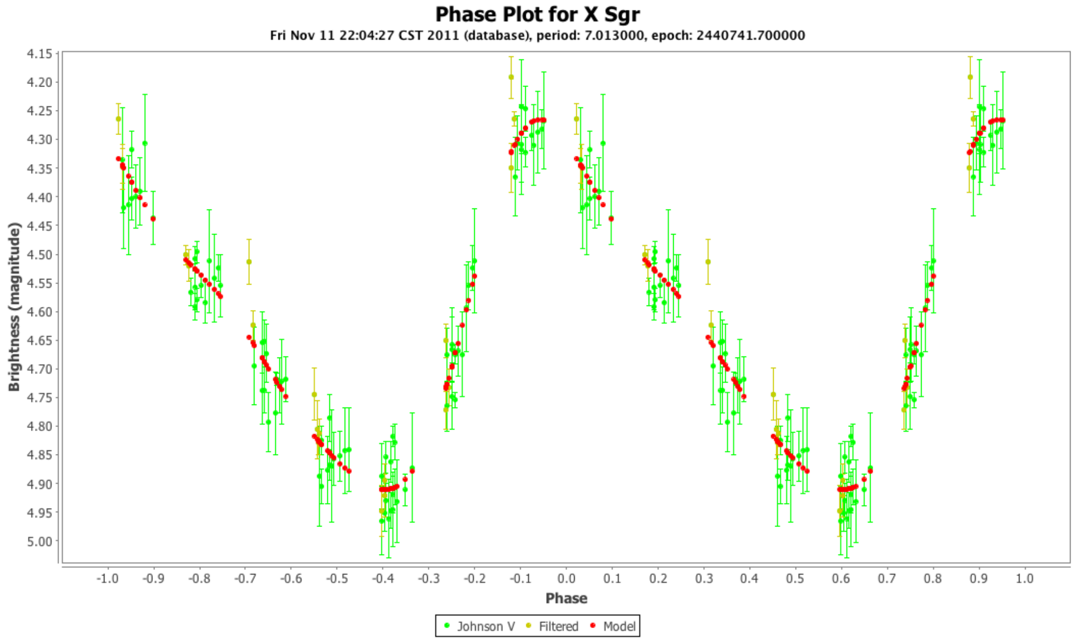

Figure 11. Phase plot of V band and 3 harmonic model for X Sgr.

Figure 12 shows the same phase plot, without error bars.

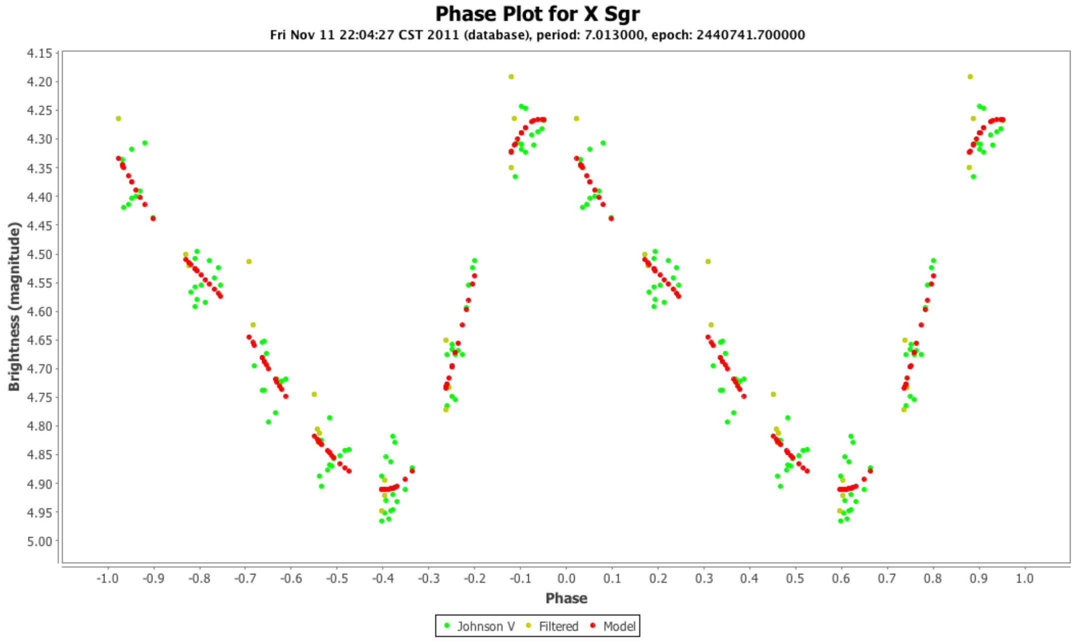

Figure 12. Phase plot of V band and model for X Sgr with no V error bars.

Period analysis and modelling are topics that, along with binned means and other statistical measures, deserve detailed treatment in future articles.

Other features (briefly mentioned earlier) to be covered in future articles are:

- multi-period analysis via the CLEANest algorithm which refines multiple periods for the purpose of creating a model;
- time-frequency analysis via the Weighted Wavelet Z Transform (WWZ).

Scripts (currently JavaScript only) can also be run from within VStar to automate tasks such as loading a number of datasets from AID and saving each to a file. This was recently used by the Citizen Sky Mira Fourier Coefficient Team to automate the downloading of a large number of datasets for offline processing. The scripting API is still early in its development but will become richer over time.

What of the future? What is missing?

In recent feedback, Tom Richards emphasised time of minimum/maximum determination as a feature of particular interest to eclipsing binary analysis and exoplanet projects (such as SPADES).

More powerful model and filter creation is high on the list as are more plug-ins (eg for additional observation sources and period analysis), O–C analysis, and of course, the inevitable raft of bug fixes.

One obviously missing item is good documentation. The help currently available (see Help menu) is minimal. In the near future I need to stop, take stock, and improve this aspect of things. I would also encourage anyone who is interested in technical writing (or software development) to contact me.

The learning curve has been steep, but watching VStar grow has been very rewarding. This is a labour of love, intended to be of benefit to the astronomical community as an open source, cross-platform tool whose capabilities will only grow in the future.

Links

- AAVSO Education: http://www.aavso.org/education
- AAVSO VStar overview: http://www.aavso.org/vstar-overview
- VStar plug-in library: http://www.aavso.org/vstar-plug-in-library
- VStar Team: http://www.citizensky.org/teams/vstar-software-development/
- VStar SourceForge site: https://sourceforge.net/projects/vstar/
- Zapper Tool: http://www.aavso.org/zapper
- AAVSO Download Format: http://www.aavso.org/format-data-file
- Analysis tutorial: http://www.citizensky.org/content/5-star-analysis
- International Variable Star Index (VSX): http://www.aavso.org/vsx/
- VStar posts to author’s blog: http://dbenn.wordpress.com/category/astronomy-science/vstar/

Equatorial Eclipsing Binaries Project – *Tom Richards*

tom@prettyhill.org

Coming to an end

The EEB project, joint with the BAA/VSS, is aimed at a close study of a small number of poorly observed equatorial eclipsers, primarily EAs. It has been running since 2009. Full information is on our website at Research Projects > Equatorial Eclipsing Binaries.

Over the last three years, we have gathered a lot of time series CCD data on EEB project stars, notably V1243 and V1692 Aql, WZ Cet, CU Hya, and UV Psc. In addition, Margaret Streamer is now running the ongoing campaign on SZ Psc – see her article in this newsletter.

The time has now come to write up the observations for publication, rather than collect more data.

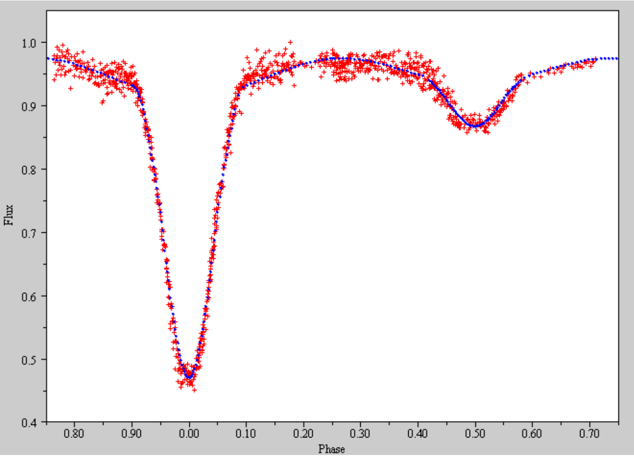

Fig 1. Synthetic light curve (blue) matched to observational data (red) for CU Hya.

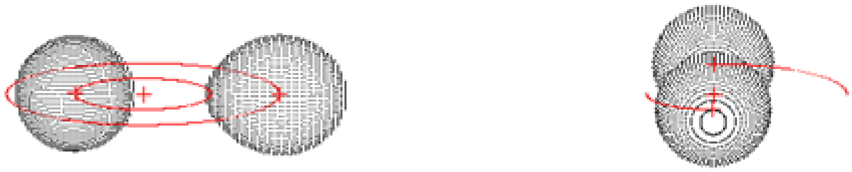

Fig 2. Model of the CU Hya system made using Binary maker 3.

A report on CU Hya has been submitted to the Journal of the British Astronomical Association. Favourable referees' reports have been received, and I will send off the final revision shortly. I'm planning to make a poster presentation on this system to the forthcoming NACAA Conference (see "From the Director" in this issue about NACAA and the VSS Symposium.) As reported in the May issue of the newsletter, Col Bembrick has developed a model of this system based on our observations. Figure 1 shows all our observational data (red) and the synthetic model curve (blue) fitted to it in BinaryMaker 3. Figure 2 shows a rendering of his model

We have obtained much data on V1692 Aql in its 2011 apparition, to complement the 2009 data. Observers this time round were Neil Butterworth, Margaret Streamer, Phil Evans, and Roger Pickard.

A draft paper on V1243 Aql is nearing completion, and Margaret Streamer will shortly start an analysis of the UV Psc data – as soon as I clean it.

It may be necessary to request some fill-in observations from current observers, but otherwise we can treat this project as closed observationally, except for Margaret's SZ Psc, which is currently well placed for observation.

I think the project has been most successful from several points of view. We're getting good science out of it, it has been a valuable learning arena for many observers, and I've certainly learned a great deal about the issues of reconciling data from different observers with very different equipment. If there's a lesson to be learned there applicable to future eclipsing-binary work such as SPADES, I'd say that we must strongly encourage obtaining transformed data, and we must be rigorous about using the same comparison star and its catalogue magnitude. Other issues, such as some observers reporting differential magnitudes and some standardized, some reporting JD and some HJD, lead to wasted time for the analyst. Observing requirements for all such issues need to be made unambiguously clear, and observers need to follow them.

The project will live on in spirit, in that the hundred-odd targets in the SPADES project are also EAs, equatorial and southern, and the same sort of time series CCD data are required. We will be analysing SPADES data both for characterizing the stars, and for detection of circumbinary exoplanets.

SPADES data is coming in by the shovelful — *Tom Richards*

tom@prettyhill.org

The SPADES project (Search for Planets Around Detached Eclipsing Stars) has certainly created a lot of enthusiasm. Observations are pouring in at a rate I can scarcely handle. Data for 34 targets are now on the website (See Research Projects > SPADES >SPADES Files), and I have a backlog of many more on my computer. Observers are required to get V-band CCD time series of the nominated target binaries in the expectation of capturing an eclipse which can be accurately timed. Many eclipse observations of a binary over several years can yield, by shifts from the predicted times, the signature of a planet orbiting the pair of stars. You can find the details of the project on our website at Research Projects > SPADES.

The discovery of Kepler 16b, a planet orbiting a magnitude-11 eclipsing binary, has provided the first concrete evidence of circumbinary planets – the objects of our searches in SPADES. Have a look at http://kepler.nasa.gov/Mission/discoveries/kepler16b/, which also contains a link to the discovery paper in Science by Laurance R. Doyle and innumerable collaborators.

We have received observations from Bill Allen (NZ), Steve Kerr (Qld), David Moriarty (Qld), Yenal Ogmen (North Cyprus) and Margaret Streamer (NSW). David, a newcomer to variable stars and VSS, has been especially prolific with observations of 16 systems. But lots more data are wanted – the more eclipses we can time the better we can pin down any planet-induced wobbles.

Needless to say, this observational flood has created quite a load of work in checking, cataloguing and extracting eclipse information from the data files sent in to me. I am being most ably assisted in this work by Mark Blackford, Roland Idaczyk, Ranald McIntosh and Margaret Streamer. This should speed up the availability of data on our website.

I would very much like to have this work spread around. The work is more routine than onerous, but doing it properly is most instructive. To do it, you need Excel 2007 or similar to read and write XLS or XLSX files, and a time-of-minimum (ToM) program such as PERANSO or Bob Nelson's Minima. If you handle this job successfully, you name will appear in the author list of any refereed publication involving the stars you worked on. Email me at tom@prettyhill.org if you're interested in doing this, and I'll send you some observation files, spreadsheet templates, and full instructions.

What sort of results are we getting so far? Few nights of observations – each totalling hundreds of images of the target system – have yielded complete beautiful eclipse curves when the observer does the photometry the next day. The eclipse is often shifted by an hour or more from the predicted time, or is absent altogether! Frustrating this may seem, but it's all important data. Most of the light elements (period in days plus an epoch - a time of minimum - as a Julian Date) go back to the variable's discovery in the 1950s or much earlier. These were made from photographic plates, often taken nights apart, so making a good estimate of the light elements was a difficult task. And over the decades since, the inaccuracies have built up to make the predictions of eclipse times very unreliable. To make it worse, many, if not most, of these stars have not been observed since discovery. So actually finding and publishing new times of minimum is

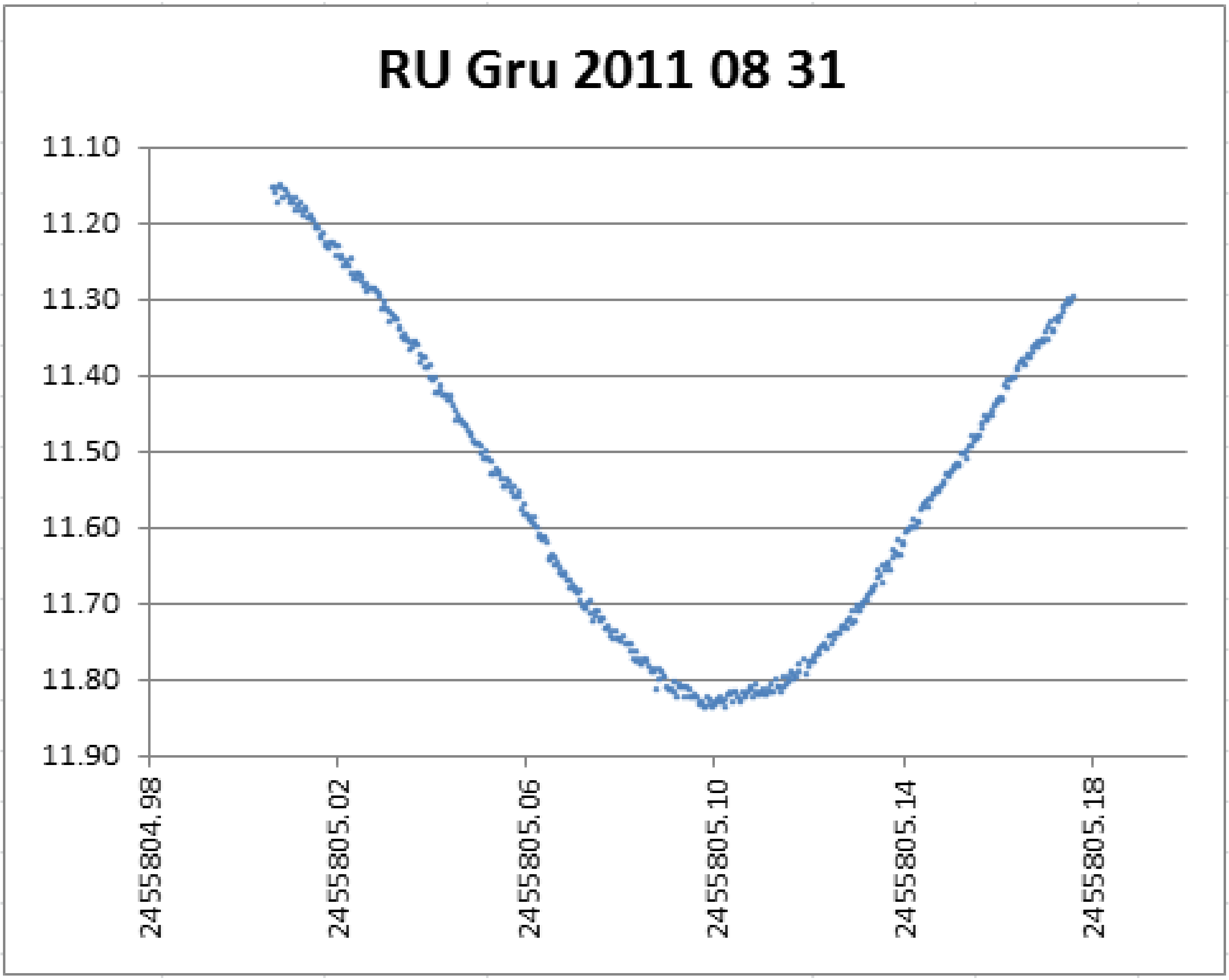

Fig 1. A time series of an eclipse of RU Gru captured by Margaret Streamer using a 14 inch LX200 scope, SBIG ST402 CCD camera and V-filter.

a most valuable exercise – both for finding variations in eclipse times that might indicate a circumbinary planet, and for the study of the eclipsing binary as a variable. And one must not discount the possibility that the original light elements were very accurate, but the system has changed since. All to be discovered!

We're now getting a lot of the data onto our website. Visit Research Projects > SPADES > SPADES Files to see the results, star by star. We're storing four types of files for each star. Take RU Gru for example (see Fig 1). One file, RU Gru Obs summary, is an Excel file listing observational information about all the observation sets made on this star to date – two of them. Eclipse times and O–C data (deviations from predictions) are included. Another, RU Gru ephemeris, is an Excel table of eclipse predictions based on available light elements. For this star we're fortunate to have the recent and highly accurate SuperWasp light elements. By downloading the ephemeris file, you can adjust the spreadsheet to cover any period of observation you like, and also try out other light elements. The RU Gru spreadsheet provides three, and it's instructive to build the ephemeris from each in turn and compare it with the observed eclipse times.

Then there's the actual observation files, more or less as submitted to me. These are in two versions. The first is an Excel file, including a dynamic light curve plot, in which you can carry out spreadsheet calculations of your own such as error estimations, conversion to fluxes, normalizations, and more. The other is a text file that extracts from the Excel file the HJD, mag, and mag error (where available), in comma-separated-values format. This can be easily loaded into a number of light curve analysis programs.

We're taking this multi-file approach for several reasons:

- Using the Obs summary spreadsheet, observers and others can easily get an overview of all results for any target, to guide further observing or to see the available ToM and O-C data.
- The ephemeris spreadsheet assists observation planning, but is also a tool for investigating and comparing different light element sets with current eclipse data. And you can try out modifications to the elements to see what effects they have on eclipse predictions. That can be quite salutary!
- The files of actual observation data can be investigated separately, to look at its light curve, study the differences between observers and nightly conditions, remove anomalous data points, correct systematic differences, and the like.
- The CSV files for a target system can be loaded separately into analysis programs like PERANSO while retaining their identity, so they can be individually normalised, measured, overlaid on the others for comparison. This provides a rich and controllable way of combining data from multiple observers and adjusting between them.

Finally, we need to enlarge the SPADES team. We need more observers to get more eclipses of more stars, and we need more back-office volunteers to pre-process all this data as it comes in, making it ready for the website. And then there will be more work to be done in future – tracking down the histories of these stars, for one thing. Then there's the meticulous measurement of these light curves and compilation of O-C data that will be carried out by Simon O'Toole of the AAO and his professional colleagues. So if any of these roles appeal to you, please send me an email!

AAVSO CCD School 2012 — *Arne Hendon*

The AAVSO will hold a CCD School near or at their Headquarters in Cambridge, MA during July, 2012. Exact dates have not been set, but will be known in early 2012. A more formal announcement will be made at that time. Prices are also not known, but the tuition will be in the US$500-1000 range and the accommodations will likely be in the same range.

The school will last from Monday through Friday, with about 8 hours/day of classes and additional homework assignments. This is an immersion school; CCDs and processing will surround you at all hours. You should already know something about CCD cameras and photometry before you arrive. The main instructor will be Arne Henden; there may be additional instructors for certain topics.

The attendance will be limited so as to provide direct mentoring and informal question/answer throughout the period. If successful, additional Schools will be held in following years.

Each student will be given a unique image dataset for processing, and we will also use AAVSOnet to acquire additional images throughout the School. The AAVSO electronics/optics lab will be used for camera calibration. Time will be made available for testing your own CCD camera if you bring it along.

Preliminary agenda:

Monday:	CCD detector and camera basics, selecting the proper camera, calibrating cameras, setting up observing programmes.
Tuesday:	image processing, basic photometry techniques
Wednesday:	statistics, proper observing techniques
Thursday:	transformation, advanced photometry techniques
Friday:	data-mining and analysis, astrophysics of variable stars from photometry, review of student projects.

VSS Research Grants

Financial members of Variable Stars South are invited and encouraged to submit applications for research grants.

The purpose of the grants scheme is to assist a VSS member or research team that has a VSS member, in their participation in a recognised VSS research project. Applications will be considered for expenditure on items such as, but not limited to, the following:

- Items of instrumentation directly relevant to variable star research such as eyepieces and photometric filters
- Software related to image acquisition, processing, measurement, and data analysis
- Charges for access to research telescopes
- Obtaining research papers for which a charge is made
- Travel necessary for research purposes, eg to libraries or public/professional observatories where observing time has been booked.

Applications for the following will not be considered:

- Observatory equipment, as distinct from science instrumentation
- Equipment or software maintenance
- Subscriptions or books
- Conference travel or travel to a dark sky site.

Conditions of Grant

The maximum amount of the application should not normally exceed NZ$250.00, and smaller requests are more likely to succeed. Grant-in-aid applications, where the proposer wishes to make expenditure in excess of the amount requested and will meet the excess in other ways, are certainly acceptable.

Applications will be judged on their relevance to the purposes of VSS and its projects, and to the extent to which they will enable the grantee to be involved in those projects.

The amount granted must be spent within one year of the date of grant. The grantee should arrange for and pay for all purchases and other expenditure under the grant and submit receipts to VSS for reimbursement up to the maximum granted. If the grantee submits receipts in excess of the amount granted, only the amount granted will be reimbursed. If the grantee submits receipts during the grant period for less in total than the amount granted, then VSS retains the unspent balance.

The grantee is required, at the end of the grant period, to submit a full report to the Director of VSS of the research carried out using the grant monies. This report will be taken into account in the evaluation of future grant applications, and may at the discretion of the Director be published in the VSS Newsletter.

The grantee is required to ensure that in any research publications of which is grantee or any member of the grantee's team is an author, whether refereed or not, and arising from research of the grantee or team that was materially assisted by the grant, whether in the grant period or afterwards; appropriate acknowledgement of the grant shall be made.

Equipment and material purchased with the grant will remain the property of the grantee, not VSS.

Submission

Applications should be in DOC or DOCX format, no longer than one A4 page of 10-point type, including any illustrations or tables.

Applications must contain:

- Full name, postal and email addresses of the proposer
- An itemised list of the proposed expenditure items. Where costing is difficult, please supply estimates.
- A justification of the expenditure.

Applications can be submitted as email attachments to the Director, Dr Tom Richards, (tom@prettyhill.org), at any time. Proposers will be notified of the outcome of their application shortly after submissions are received.

About

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

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

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

VSS is entirely an Internet based organisation, working through our website http://www.VariableStarsSouth.org and its e-group http://groups.google.com/group/vss-members. It also encourages members to work 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 online payment system, from your credit card or bank account.

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

NEWSLETTER ITEMS

These are welcomed and should be sent to the Editor. 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 February, May, August and November, nominally on the twentieth day of these months and the copy deadline is the thirteenth of the month though earlier would always be appreciated.

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