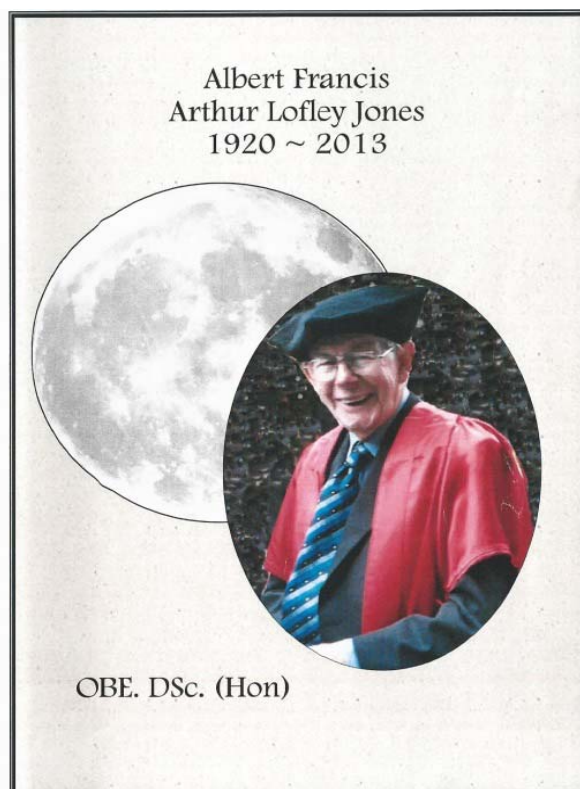


ALBERT JONES 1920 – 2013



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ALBERT JONES 1920 – 2013

Albert Jones passed away at the age of 93 in September and on Monday 16th September I, together with many other New Zealand astronomers and friends, attended his funeral and the celebration of his life in his home town of Nelson. He is survived by his wife Carolyn. The photo on the front of this newsletter is a copy of the funeral service sheet frontpiece with Albert in his robes during the graduation ceremony where he received his honorary degree of DSc for his outstanding contribution to science, and his OBE for his services to astronomy. The remaining photograph is one of his famous homemade 12 inch telescope which he called 'Lesbet' now residing in the Archives of the Nelson Museum.

Albert was a remarkable observer of variable stars with over 500,000 observations to his credit. The first recorded in the AAVSO database was CP Pup on January 18, 1943 and the last received V776 Cen during August 2011. Albert's scientific achievements are outstanding and more remarkable because they were made visually with his homemade telescope from his backyard. His visual observations, to 0.01 magnitude, are so accurate that they are used by professional astronomers throughout the world. He contributed to a range of scientific programmes and was a co-author on many international publications.

He has also discovered two comets while "star hopping" between variable stars, as he called it, the first in 1946 when he was 26 and the second in 2000 when he was 80 making him the oldest person to find a comet. The 54 year gap between the two discoveries is also a record. His greatest discovery was supernova SN1987A in the LMC. Mt John University Observatory, local and overseas observatories were alerted, allowing astronomers to study the brightest naked eye supernova since 1604.

Albert was honoured by many institutions including the RASNZ, RSNZ, AAVSO, Smithsonian Astrophysical Observatory, Astronomical Society of the Pacific, BAA and many others. He was one of the first four Fellows of the RASNZ in 1964, awarded an OBE in 1987 and, in recognition of his achievements to science, asteroid 3152 Jones was named after him. He was an honorary life member of Variable Stars South.

Albert and Carolyn were one of the nicest couples I have ever met. Albert was quiet and unassuming, full of knowledge and only too pleased to help you in any way. I remember many a time visiting them in their Nelson home sitting around the table eating Carolyn's wonderful cooking and talking variable stars. He was a mentor to us all and will be missed. —*Bill Allen*



From the Director - *Tom Richards*

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Vale Albert Jones

I'm sure all readers will know that Albert has passed away. He was undoubtedly the greatest figure in New Zealand amateur variable star astronomy; and many in VSS treasure long and happy memories of their association with him. In my case unfortunately, I met him only once, and briefly.

It will be a long time before there is another of his stature.



Coming to NACAA XXVI in Melbourne?



Easter is always the time for the National Australian Conference of Amateur Astronomers – every other Easter, that is. Some grumble, but judging by the turnout it suits a lot of people, many combining it with family holidays. In 2014 it's hosted by the Astronomical Society of Victoria, who superbly hosted VASTROC, the Victoria-wide equivalent, at the same venue (Rydge's in Preston, Melbourne, nicely accessible from Tullamarine Airport). April is usually wonderful autumn weather in Melbourne.

NACAA is where the "serious" amateurs foregather to discuss research and technology. It's an important venue for variable star researchers, both to discuss their work and to encourage others to take part. The last two have been very important for the development of VSS, and this one promises to follow the trend.

The NACAA conference website is <http://www.nacaa.org.au/2014/about>. Thinking of submitting a presentation proposal? Oral presentations need their proposals in by November 15th, posters February 15th. Give it a go - at least a poster. Dates: April 18-21.

Then there's RASNZ/VSSS3 in Whakatane

The Variable Stars South Symposia run at two-yearly intervals, alternating across the Tasman. VSSS2 was held with NACAA 2012 in Brisbane. Next year it's with the RASNZ conference in Whakatane on Monday June 9th. The conference proper is on the preceding Friday night through Sunday. Have a look at <http://www.rasnz.org.nz/Conference/> for all details. Incidentally Jocelyn Bell Burnell is speaking.

RASNZ and NACAA conferences are of a similar level and style. Both are aimed at the serious amateur with a strong bias towards research and technology, though RASNZ usually has a lot more professionals attending. Usually each has half-a-dozen attendees from the other side of the Tasman.

That raises the question, if you're attending both as I will be, can you repeat your presentations? My view is that with the small overlap and given these aren't fully refereed academic conferences that go on your professional CVs - yes you can present the same at both. If you've got something worth saying, both audiences should hear it and you should get feedback from both. Certainly for posters there is no doubt; but for oral presentation I myself would change the title and contents a bit, and apologize to the tiny coterie who heard it at the other conference.

RR Lyrae project starts up

In the last Newsletter, Stan Walker outlined an RR Lyrae project for VSS members, and asked for someone to run it. David Moriarty of Brisbane has volunteered, and will make an excellent leader with all his experience in the similar observational field of eclipsing binaries.

If you have a CCD or DSLR system, RRs are possibly the easiest and most rewarding area of

study. Like eclipsing binaries, the idea is to set your telescope tracking the target all night long, obtaining a time series of many hundreds of images, and sleep through it. But unlike eclipsers, you don't have to find out first whether there's a possible target eclipsing around midnight from your location, and near your meridian, so you can get a good coverage of the eclipse. RRs are changing all the time, and fast, so you can get a lot of valuable data in one night. Stan's article shows light curves for BH Pav ($P = 11.447$ h) and HX Ara ($P = 5.625$ h) by member Paul Luckas. If you have photometric filters, alternating B and V, or even I, can provide important temperature change data.

Think this is for you? Contact David at djwmoriarty@bigpond.com, and get going. As a guide to observing, you could just follow the observing guide for the Eclipsing Binary Programme, *mutatis mutandis*, and use its observation report form (download both from the website at Research > Eclipsing Binaries > Eclipsing Binary Programme). It will take a while for the RR Lyrae area to get set up on the website, and to choose an observing list of targets, but just stay in contact with David in the meantime.

Recovery of spectral types in Sagittarius — *Mati Morel*

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There are many lists of data, decades old, of various kinds, which languish in obscurity until they can be put into a computer-readable form. My friend Brian Skiff of Lowell Observatory is the acknowledged guru in this field. A considerable body of his work can be found at the FTP site: <ftp://ftp.lowell.edu/pub/bas/starcats>

Many of his lists eventually migrate to the CDS site, to become accessible online via the VizieR search page. Quite recently I have completed a task to recover 1684 spectral types around Selected Area 158 in Sagittarius. I use the word 'recover', as the data, published by McCuskey in 1964 was in a form which was unusable. Identification charts (based on photographic imagery) were published, but on the printed page were just so crowded and cluttered as to be unreadable. Extraction of precise positions for all of his stars had to await the release of deep survey catalogues in the last 15 years, such as UCAC2, 2MASS and others.

My work employed the principle of Concordance of Evidence, ie employing different lines of evidence or different sources to ensure that identifications are grounded as securely as possible. It is worth noting that some entries coincide with known variable stars.

I have produced a file (SA158.DAT) which lists all of McCuskey's data. GUIDE9 was used to generate on-screen plots for comparison, from which precise positions were retrieved. The field in question covers 25.2 sq°, from RA 18h 18.0m to 18h 41.0m, and Dec $-27^{\circ} 25'$ to $-32^{\circ} 15'$ (J2000). The magnitude limit is about 12.0ptg. My file provides other identifiers (HD and DM numbers), which are not in the original paper, as well as additional remarks.

The file has been sent to Brian Skiff, who has an ongoing project to compile published spectral types into one master catalogue. The file is also available on the VSS website as an addition to the list of Catalogues and Databases. The same file elaborates further on how the work was done.

Biographical information for K Nakamura (8 April 1904 - 24 Sept 1932)

The following note appeared in AN247,71 (1932).

Death Notice

On 24 September 1932, Kaname Nakamura, Senior Assistant at Kwasan Observatory, Kyoto, passed away at his birthplace, Mano-Mura, Omi, Japan, at the age of 28 years.

The letter of the director of Kwasan Observatory, Professor Issei Yamamoto, in which the writer communicated the death notice, has detailed the following particulars about the deceased. K. Nakamura was, for more than 10 years, engaged as an observer at Kwasan Observatory and was busy in this way with comets, minor planets, meteors, variable stars, planetary surfaces and sunspots. He also busied himself as a practical optician, in which more than 300 mirrors and 40 lenses were ground for himself, his friends and other institutions. His passing leaves behind, besides, a greater quantity of unfinished work, whose completion and publication is especially being attended to. —*H. Kobold (editor)*

Comment

It is evident that he had a relatively short, but busy, life. Nakamura joined the AAVSO in 1922 at age 18, the minimum allowable age. He contributed variable star observations to the AAVSO for only two months (August and September) between November 1921 and October 1922. His instrument was a 3-inch (refractor). It is no disrespect to surmise that on account of his youth, his experience in variable star matters in 1922 would have been very limited.

Kwasan Observatory was founded in 1929, with Prof Issei Yamamoto as its first director. Nakamura was employed at Kwasan Observatory at the time of his death, but prior to that year he was evidently on the staff of Kyoto University Observatory.

Reference

McCuskey, S.W. 1964. *Astron. J.* 69,104

Addendum to newsletter 2013-2, p11. Note on NSV 7590 — *Mati Morel*

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NSV 7590 probably constant

Position: (B1875) 07h47m17.92s -27°57'40.9'
(B1950) 07 50 20.90 -28 09 08.4
(J2000) 07 52 22.92 -28 16 56.5

Also known as GSC 6565 555, this star was noted as a possible variable on RASNZ chart 1061 (Bateson and Morel 1992), based on discrepant measurements published by Reed and Fitzgerald (RF) (1984). These authors recorded their measurements under two different names, as follows:

RF #	V	B-V	Spect
C4 2	11.63	1.47	M0 III
D4 59	10.25	1.56	M1 III

Note : Photographic photometry.

The pathway towards obtaining the original identifications by RF is rather opaque. They published neither coordinates nor charts, but their data was issued on a microfiche card, and not available online. However, charts could be obtained (in 1989) from the Royal Astronomical Society library, and the complete catalogue was reproduced on paper by W Buscombe in 1988 (without coordinates). From the secondary sources I compiled a list of approximate coordinates for all RF stars. This file is on the VSS website. Go to :<http://www.variablestarssouth.org/information-and-resources/catalogues-a-databases> and scroll down to Database for Stars in MWF 245 (Reed), and download.

The RF star has been given the name NSV 17642 in the Supplement to the NSV catalogue.

The star in question lies in a narrow overlap region of two adjoining plates, hence the duplicate measurements. In 1992 it was not possible to verify the published data, nor check for variability. This can now be done, yielding the following data, and their sources.

V	B-V	Source
11.625	1.368	Tycho-2
11.78	1.63	GSC 2.3
11.29	1.21	SPM4
.....	1.24	2MASS
11.523		ASAS-3. Err = 0.038, dataset 1, 269 obs. [ASAS 075223-2816.9]
11.532		ASAS-3 Err = 0.038, dataset 2, 334 obs. [" " "]
11.514	1.389	APASS (29)

The ASAS-3 lightcurve is quite flat, at around $V=11.5$, with no evidence of the star reaching 11.0, let alone 10.25. The latter measurement by RF appears to be an isolated value, inconsistent with its “normal” magnitude. Several photographs have also been examined, dating from 1927, and mid-1960s, and all are consistent with the star being of $V=11.5$, or $B=13.0$. The single measurement of 10.25V is hard to explain, but the star’s position at the extreme edge of the photographic plate may indicate a flawed image, or some other non-astronomical cause. The spectral type is quite secure, and small-amplitude variations would not be at all unusual. The ASAS-3 lightcurve, however, indicates constant brightness.

References.

- Bateson, F.M. and Morel, M. 1992. Charts for Southern Variables, Ser. 23. Astronomical Research.
 Buscombe, W. 1988 “MK Spectral Classifications, Seventh General Catalogue”. Northwestern University, Evanston.
 Reed, B.C. and Fitzgerald, M.P. 1984, MNRAS 211,243 [1984MNRAS.211..243R]

RR Lyraes - some summer targets – *Stan Walker*

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As Tom mentions, there is very good news in this area - David Moriarty has volunteered to coordinate this project. It needs someone with the time to do this effectively and I’m fully occupied with Miras and classical Cepheids. There have been some very interesting developments in analysis initiated by Mark Blackford and those interested in this should read the article elsewhere in this Newsletter.

Whilst David is preparing for his role I offered to suggest some targets for summer months. So a listing of relatively bright objects is shown here. There’s not much information on epochs but you should visit the GEOS RR Lyrae survey (<http://dbrr.ast.obs-mip.fr/>) which provides O-C diagrams of many stars and epochs.

Star	Mag	Star	Mag	Star	Mag
XZ Cet	9.24	RX Col	11.4	RT Col	12.4
RW Col	11.5	RY Col	10.44	RT Dor	11.8
SW Dor	13.5	SX Dor	13.5	VW Dor	11.22
XX Dor	11.23	RX Eri	9.17	SV Eri	9.56
BB Eri	10.96	BK Eri	12.00	BY Eri	12.13
CS Ori	8.75	DT Eri	12.5		

Table of summer targets for the new RR Lyrae project

For the time being, those using DSLR cameras should follow the guidelines for imaging and data reduction for Cepheids:

<http://www.variablestarssouth.org/research/intrinsic-variables/bright-southern-cepheids-for-dslr-similar-cameras-2>

Those who use CCD cameras should follow the guidelines here:

<http://www.variablestarssouth.org/techniques/observing-a-reporting>

Send data files to David Moriarty.

I presented a paper on this star at the recent RASNZ Conference in Invercargill. This will later appear in *Southern Stars* once it can be changed into an adequate format for that publication. The expense of colour printing means that graphs are preferred in black and white which is rather inhibiting. But on to the observing.

There are some good BVRI measures of BH Crucis appearing on the AAVSO website, mainly by Neil Butterworth, Giorgio di Scala and Michael Heald. These confirm the colour variations described earlier (Walker, 2009, eJAAVSO, 37,2,87) with B-V about 2.7 at maximum and 4.5 at minimum but they also provide R and I light curves which have previously been unavailable. The interval since JD2453000 is shown in Figure 1. The first maximum has been submerged by the brightening described in that paper but it can be seen during the rise to maximum in early 2010. Unfortunately in the last two rises to maximum the phase of the previous first maxima is not well covered. There is a suspicion of a hump at this phase in the visual data.

Measures of BH Crucis from the International Database of the AAVSO (AID)

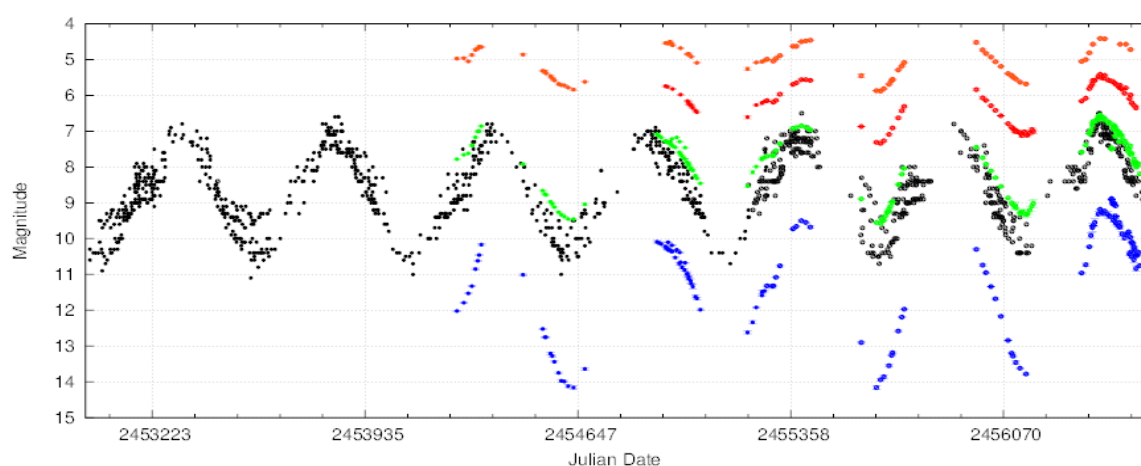


Figure 1. The last 2850 or so days of BH Crucis prior to 30 September, 2013. Whilst the first maximum has largely disappeared it is still detectable at times in the BVRI measures. With the change in period from 421 to 525 days the mean brightness of BH Crucis has increased, but almost entirely as a result of an enhancement of the second maximum. As the star is significantly cooler than in the 1970s these changes need to be explained as a major radius variation. Two JH measures by Giorgio di Scala have been omitted for the sake of the scale but were around 2.6 and 1.6 respectively.

One of the interesting aspects in a comparison of R Centauri and BH Crucis in the 1970s was that in the first case the first of the two visually equal maxima is the bluer and hotter - in the latter case the second. But the recent BVRI data are fragmentary and do not provide an opportunity to extend this comparison to the present time. The colours have been similar for the last 15 years.

This gets us on to colours. Whilst the V or vis light curves give a reasonable picture of how the brightness varies measures through other filters tell us something about temperature changes and, from this, radius or size changes. The presence of two maxima in these stars of detectably different colours and temperatures poses the question - what exactly is happening? It's not a simple radial pulsation phenomenon, nor is the true period half the observed one as some researchers suggest. So this suggests that BVRI measures at intervals of two to three weeks, but particularly at both maxima and minima, would be valuable. A forecast of these dates appears in the table overleaf.

Name	Max	Min	Period	Min I	Max0 I	Min II	Max II
V415 Velorum	9.8	12.5	413	9.9.2013	6.11.2013	26.3.2014	30.5.2014
BX Carinae *	11.7	13.8	427	29.10.2013	18.3.2014	11.6.2014	14.9.2014
BH Crucis	6.5	9.8	525:	18.10.2013	18.4.2014	Filled in	3.9.2014
TT Centauri *	9.0	<15	462?	13.7.2013	6.11.2013	1.2.2014	6.4.2014
R Hydrae	3.5	9.5	388	19.6.2014	See text	See text	5.1.2014
R Centauri	5.8	9.0	500:	31.10.2014	29.9.2013	4.3.2014	10.6.2014
UZ Circini *	9.2	14.0	538	23.2.2014	13.7.2014	11.10.2014	9.8.2013
R Normae *	6.4	12.0	507	24.7.2013	14.11.2013	22.2.2014	12.5.2014
BN Scorpii *	9.6	5.0	616	14.7.2013	24.10.2013	3.3.2014	19.7.2014
U Canis Min*	8.0	14.0	414	9.10.2013	23.12.2013	28.2.2014	6.5.2014

Ranges, periods and forecast events over next cycle. Dates are JD - 2400000

The table also includes R Hydrae. This star had a period of well over 500 days in 1666 but this changed over almost three centuries to 388 days. Its light curve at times shows humps on the rise and a wide flat maximum. Unfortunately maximum over recent years coincides with its passage close to the Sun so observing is difficult. Visual observers could concentrate on the stars marked with asterisks where no well observed recent epochs are available. But don't abandon the others.

U Canis Minoris is an addition to this group, based upon the AID database lightcurve. It's not well observed although at 8N it's easily seen from these regions. A light curve is shown below. There are some BV measures over the last two cycles. A galactic latitude of 14.87 and a maximum of $V = 8.8$ suggest an intrinsically much fainter and perhaps different object than most of the above. $B-V \sim 1.6$ doesn't show much indication of any interstellar obscuration to make it faint. This star deserves some attention and is a good summer object for BV measures. These should clarify the duality picture.

Measures of U Canis Minoris from the International Database of the AAVSO (AID)

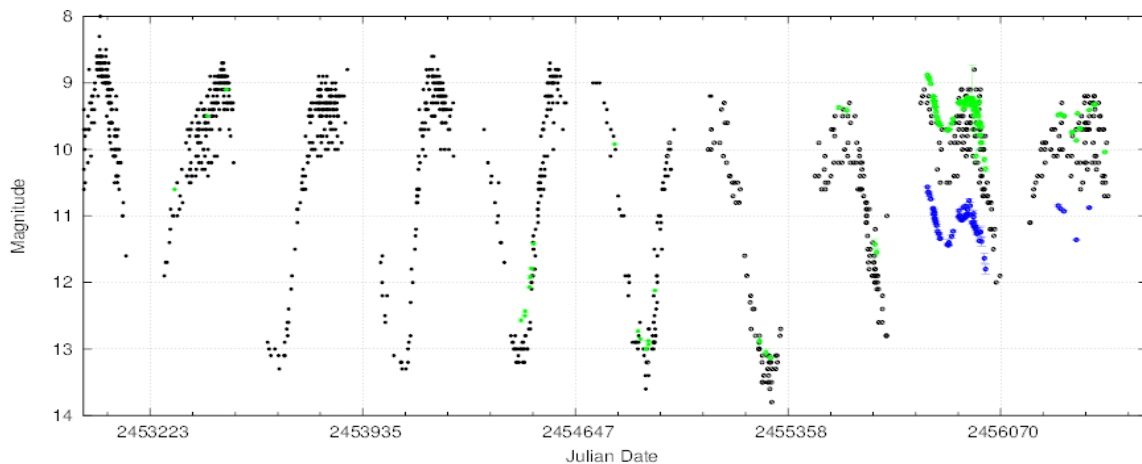


Figure 2. Over the last few decades this star sometimes looks to have dual maxima, at other times the break when it's near the Sun causes confusing gaps. But the B and V measures seem a strong indicator that it is, at least at times, a dual maxima star.

V415 Velorum is a particularly interesting target. It's listed in the GCVS as an SRa star due to its low amplitude although both visual observers and ASAS3 have the range above the minimum of 2.5 magnitudes for Mira stars. It is currently near maximum though a decline is imminent. Visual measures during the past maxima have been confusing which fact in itself is puzzling. The AAVSO chart is reasonable with magnitudes from APASS - although reducing the size to 30' and limiting the magnitude to 13.5 provides a much less cluttered view. It would be good to get some BVRI measures to see why the amplitude is so low - is it an extremely red object like BH Crucis, or does it have an unidentified close companion?

The bright low amplitude SR stars have been removed from the list as they have been shown as not DMMs. One possible northern object, T Cassiopeia, would also prove interesting if any northern observers can work on this. Neil, Giorgio and Michael have produced valuable BVRI data for BH Crucis, whilst Peter Williams, Andrew Pearce and others continue to provide good visual data to check periodicities.

Why are these objects mainly confined to a small region in the southern hemisphere? The most probable explanation is that they represent a very brief phase in the evolution of Mira stars and by chance most of the bright ones are visible from here. If a survey could be extended down to $V = 15$ this imbalance might even out. So this suggests a useful project for some of our members who may wish to do some data mining in places like ASAS3. They may well have been classed as Miras or SR objects with periods in the 210-260 day range. Or they may be poorly studied objects with maxima ~ 13 -14 and periods of 400-520 days.

The dual maxima may well be associated with imminent period changes. Two of the eight stars show this and for the other well known Mira period changers there is little known about them prior to the changes. The dramatic changes in the shape of the light curves of BH Crucis and R Centauri lend weight to this argument although LX Cygni, which recently showed a fast 20% period change very similar to BH Crucis, does not appear to have shown double maxima. The observational data for LX Cygni could be better.

One thing they have in common is long periods - even R Aquilae, another well known changing period Mira, may have started the present period shortening from the 400+ day range. A search of the known parallaxes is confusing and shows a much wider range of mean absolute magnitudes than is expected - but most of the parallax values are small with large errors which may contribute to the apparent

spread of ~ 5.0 magnitudes absolute. It must be remembered that absorption bands also play a large role in the light variations so it's difficult to compare the CS star BH Crucis with oxygen rich stars like R Centauri and R Normae. As well, some of the published measures may be wrong - it's hard to reconcile T Cassiopeia's spectral class of M8 with a Tycho B-V of ~ 1.2 , equivalent to $\sim K5$.

In 2005 Lebzelter et al, A&A 431,623-634, published some infra-red RV measures of stars including R Centauri and R Normae. A phase graph of R Normae appears in Figure 3.

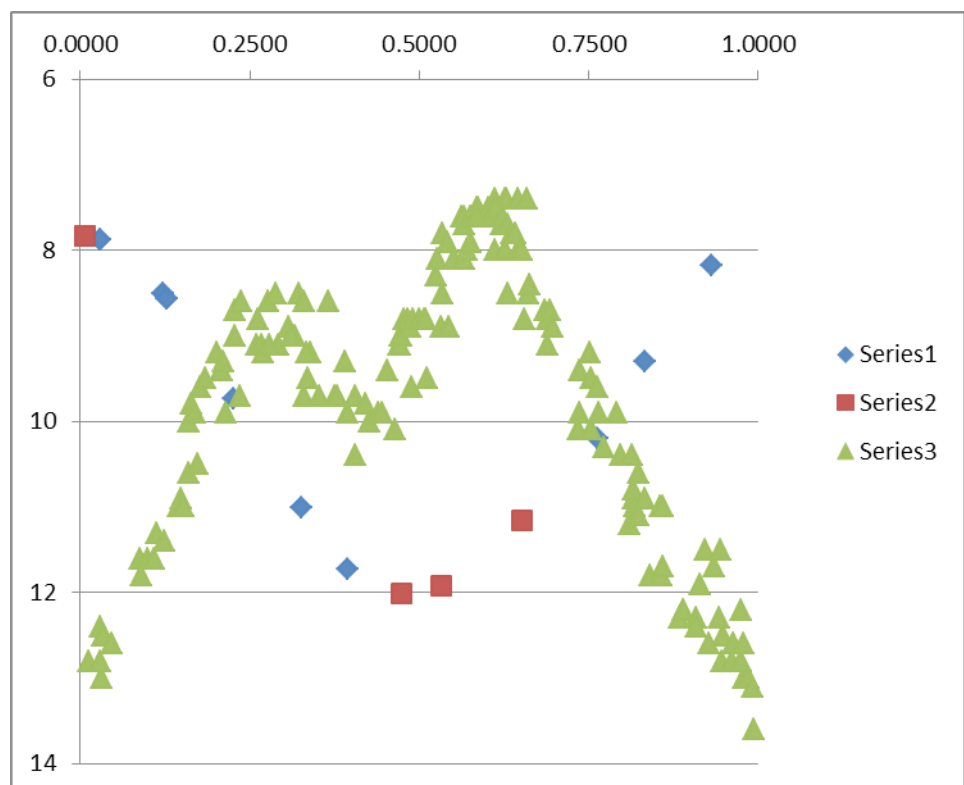


Figure 3. The green triangles represent individual measures of R Normae in 2001-02. The squares represent the radius variations with maximum radius at the top. Red indicates interpolated measures, blue actual measures. The amplitude is ~ 160 million kilometres or ~ 102 solar radii. Mira stars are large and the tenuous envelope adds complications to the interpretation of what we're seeing. The pulsation velocity range of this star is from 30.3 to 15.6 km s^{-1} .

The green triangles represent visual measures folded with a period of 507 days. There is more scatter than normal, probably explained by the star being in the process of briefly switching from the longer 507 day period to 493.3 days which it does at intervals of ~27 years or 20 cycles.

Some BV measures of R Normae were made by Neil Butterworth after the interval shown in this figure. Whilst sparse, they show a significant brightening of the B-V colour, probably a temperature increase, in the phase near 0.20 and this is probably associated with the first peak. As it's expected that the temperature will be greatest near and just after minimum radius the dip between the first and second maxima is unexpected given that it's near minimum radius. Perhaps there is little temperature change during a cycle - which is what B-V measures through a complete cycle will help to find out - and some other event causes the dip.

One idea explored in the 1970s in connection with Mira stars involved the concept of a periodic mass loss at maximum radius which material was then being accreted onto a companion star to account for X-ray objects. Mass loss undoubtedly occurs - the continued faint state of L2 Puppis is attributed to a mass loss episode and the R Corona Borealis phenomenon is well known. Ideas worth exploring, but first the measures are needed and these stars haven't been in the limelight for some time.

In discussing Mira stars I've often mentioned period alternations. Figure 4 shows an O-C diagram of R Normae with epochs based upon the second maximum which appears, in this case, to be the dominant maxima of the two. Like many of these stars it has been observed for more than a century, the first epoch recorded in this graph being in May, 1904. The period alternations are clear - it switches from 488.33 to 507.00 days and at the time the original of this diagram was prepared the mean period was 495.3 days. But the extra five years of data will probably have changed this value.

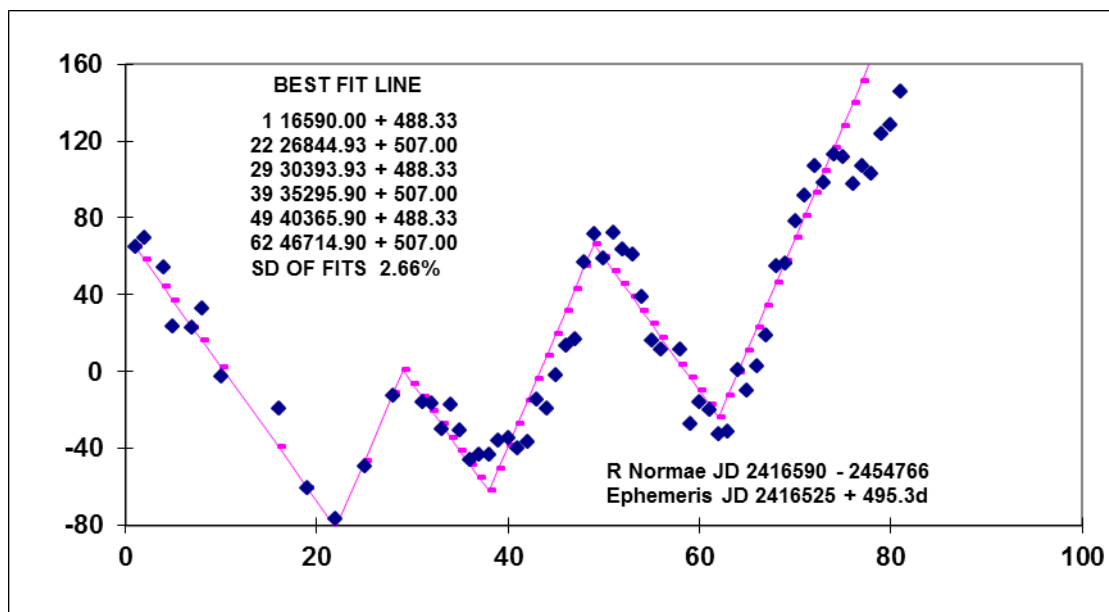


Figure 4. Epochs since 1903 based almost exclusively on visual measures of the dual maxima Mira, R Normae. There are some missing and at times the lack of measures at maximum made the determinations less than ideal, say +/- 10-15 days. The presence of alternations is quite clear.

The possible reversal in 2003 persisted until 2008 but the star has now reverted to the longer period over the last three cycles. One theoretician used the catchy alliteration 'meandering Miras' to describe these changes but they are quite clearly not meandering but alternations of period. Why these occur is an unanswered question.

In most of these stars the accumulated deviations from the mean do not exceed 40% of the average of the two periods. Reversals seem to come after about 20 cycles but this number is highly variable. Almost certainly we're seeing some kind of mechanism in the envelope which maintains a

balance by this switching. Changes in the number of massive convection cells has been suggested but there are other possibilities. The stars themselves may not be completely spherical but this should not affect pulsation periods.

The radial velocities of Figure 3 were measured at Mt Stromlo just before the disastrous fire, using a large telescope. The stated accuracy is 0.4km/sec but some of the few measures of R Centauri at similar phases show conflicting values. I have no idea what is possible in radial velocity measures with the instruments some of our members are using but it might be possible. Certainly it would add some valuable knowledge to our understanding, or lack of, with these very unusual stars.

An update for classical Cepheid observers with applications to the RR Lyrae project – *Stan Walker*

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The idea of the project is to determine annual epochs of maximum so that these can be published but also fitted to an O-C diagram to show period changes.

It is not necessary to observe these stars through a maximum. This is not really possible, given the periods, and like all pulsating variables there is some variation in the amplitude and period. In Cepheids it is very small but better results are obtained by averaging a number of cycles over the season which is usually six months or so as most of the targets lie in the Milky Way.

Epochs are best determined by fitting a dozen or so measures to a mean light curve. They preferably need to be distributed evenly between the rising and falling branches of the light curve. Measures near maximum and minimum, when the brightness is not changing as much as in the middle of the range, are of less use in determining epochs. This is in complete contrast to eclipsing binaries.

To determine a mean light curve we need about 50 good quality measures in B and V covering the complete cycle. There are some from the Auckland and Milton Road Observatories available and Neil Butterworth has also provided intensive measures of a few stars. There is also the ASAS3 database which provides several hundred measures of these stars, but the bright limit there is around $V = 7.5$ before saturation distorts the measures. A compilation of these mean curves will allow publication of epochs of maxima obtained since 2011.

Epochs of maximum are determined by fitting available B and V measures to the mean light curve using a least squares method. In theory three good measures near the middle of each of the rise and fall will provide a quite accurate epoch but we'd prefer 12-15. More are superfluous except for those stars where mean light curves are not yet available. Observers need not worry much about R and I as, like most pulsating variables, the amplitude is quite small through those filters.

This method is also what was suggested for the RR Lyrae project. With those stars it's easy to measure a complete cycle of most targets and use this as the mean light curve. Admittedly many of those stars have a long secondary period which causes the mean brightness to vary. But as long as the random measures are equally spread between rising and falling branches of the light curve the determinations don't suffer - it's only the formal 'noise' value which increases.

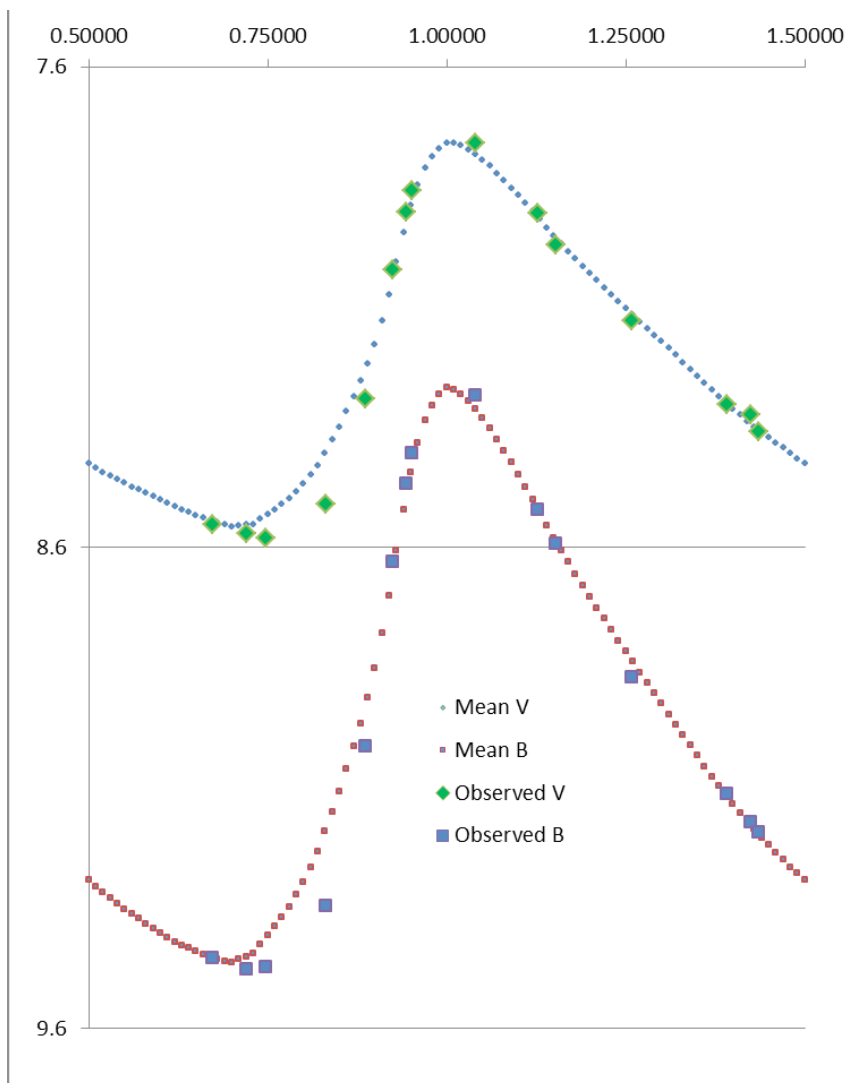
How accurate is this approach? The mean light curve of AG Crucis as measured at Auckland in the 1970s forms the framework of Figure 1. The mean curve is based on 89 measures spread over 13 years. We used a running mean to derive this - with the result that the amplitude is compressed with maximum and minimum a hundredth or two fainter and brighter respectively. The beginning of the rise was poorly observed and is a little distorted. To this have been fitted 15 consecutive observations spread over two years. Working in Excel a crude fit of the 15 observations indicates that the epoch of maximum is occurring about 0.1 days early when using the GCVS ephemeris.

The goal is to determine as many reliable epochs of maximum as possible with the minimum of observing. Given the far greater collection efficiency of CCD and DSLR cameras these 15 data

points would take about an hour to collect - but there are three other targets in the field of the DSLR so the efficiency is again improved.

Figure 1. 15 consecutive measures of AG Crucis fitted to a mean light curve. Most fit well except where the mean curve itself has been distorted by an unequal distribution of measures. The fit provides an epoch accurate to ~ 0.003 of the period, in this case 0.0115 days or 16.6 minutes. For a longer period Cepheid such as *l Carinae* at 35.5 days the values are 0.106 days and 2 hours 33 minutes - all very acceptable.

In the analysis of *l Carinae* the mean curve was improved by determining the maximum and minimum and then stretching the mean curve so that it more truly conformed to what the star was doing, hence the errors were reduced even more. But the visual measures, with a variety of values in the comparison star sequences, are confusing - however they do support the idea of some fluctuations in period.



There is a great number of stars out there, many poorly observed. And many have periods which vary. So for pure time series photometry - mainly searching for period variations - a speeding up of the observing method is highly desirable and can be achieved in the manner described.

When this project began we expected to draw charts and supply comparison star values for a limited number of objects. But it has expanded and a more DIY approach seems necessary. So let's look at two aspects of this - calibration and comparison values in the field.

In order to minimise the effects of extinction you should follow widely accepted procedures by ensuring the comparison and check stars are similar in colour to the variable and close to it in the sky. The method described here determines transformation coefficients which do not exclude secondary extinction (always present if stars are different in colour) but provided the stars have similar colour it will have little effect on the accuracy.

You need to measure a dozen or more stars for which magnitude and colour are well known. The best source of these is the Cape UBVRI standard catalogue with 9 E Regions at 45S declination, 3 F Regions at 75S and the SMC and LMC. For most southern hemisphere observers the E Regions are within 30 degrees of the zenith which allows some simple procedures. I can provide a copy of these catalogues together with the Graham extensions and these will be added to the VSS website shortly.

Some observers prefer Landolt's standards as they are close together and go to fainter limits but there should be no problem in filtered UBVRI measures of the magnitude 9 and 10 Cape stars - if you're worried about saturation then stop down the telescope aperture with a cardboard mask on the corrector plate with an off-centre 70mm circular aperture. This will reduce sensitivity by about two to three magnitudes during the calibration procedures. The Cape system is better organised and lends itself more readily to the procedures described here.

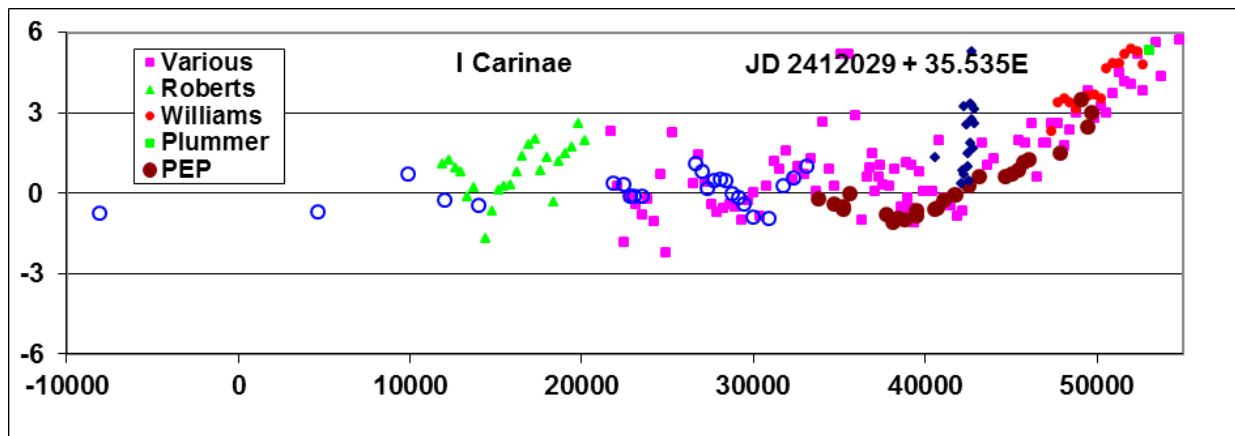


Figure 2. Shows an O-C diagram of *I Carinae* from 1891 to 2011. Conventional wisdom, based upon models of evolution across the instability strip, suggest we should find a continuous but slight period change which would appear as a parabolic curve. Instead there is an abrupt and quite large period change about 1963 and the suggestion of a cyclic variation. The very early measure in 1837 is Parenago's interpretation of data from Herschel. Other epochs determined by Parenago show as blue circles. The blue diamonds represent an attempt by another visual observer to determine epochs for well observed individual cycles - that doesn't work, obviously.

Select a region close to the meridian and collect images of 12 or more stars with a wide spread of colours. This may take between 3 and 6 images, depending upon the field of view of your CCD and telescope. If possible repeat this process in reverse. Then use your image analysis software to provide raw magnitude values in all the filters used. The blue images will appear fainter but this is irrelevant as this is taken into account in the reductions later.

Then plot various filters:

- b-v against B-V
- v-V against B-V
- v-r against V-R
- r-i against R-I
- v-i against V-I

You may not have all of these, or wish to use all of them, and the first two are adequate for the project.

This will provide a series of slopes which can be used to transform the data to the standard system. It is conventional to use lower case for the instrumental magnitudes, upper case for catalogue and corrected values.

You will need a chart for each target star. These can be prepared from any planetarium software or downloaded from the AAVSO website. But it's unlikely that there will be B and V values for most of the stars in the field. So we resort to the E Regions to resolve this problem. Always do this on a clear night with little moon.

Select an E Region to the east of the target star and one to the west. Then find an area in these where you can image some stars with B-V ranging from 0.2 to 0.6 which will cover the range of RR Lyrae objects. If you're interested in some of the fainter classical Cepheids then you may need to go a little redder, say 0.6 to 1.0, to match the GCVS spectrum. Probably three such stars in each field are adequate. Then image the eastern set, the target star area then the western set - then reverse the order - west, target, and east.

Reduce all the stars measured against one of the stars with a known catalogue value. Include in this the best stars in your target field - the raw intensities will show the best choices. Calculate the deviations of the known stars and then adjust the selected stars in the target area. From these select a comparison and check star with colours similar to the variable. These will be used in all future measures of the variable.

rial standards if the target stars are north of 20S. If you have several close together fields then you may wish to squeeze two, three or even more target fields between the E Region standards. This should present no problems.

You should repeat this process after a few weeks. The APASS project is also working in this field but their results are by no means complete, and the usable range is $V \sim 10$ to 16. We prefer B and V as data in these passbands goes back to the 1950s and the amplitude of almost all pulsating variables is greater in B than R. In fact, R is not used much by professionals who seem to prefer V-I as an equivalent of B-V for first look temperatures of stars. So B and V allow us a much longer historical baseline.

Mark Blackford is working on a Mean Light Curve/Epoch Determination spreadsheet which dramatically improves and speeds up the processes described in this article. I've used the prototypes and they're very effective. This will be available shortly, once the documentation is written up. Then the backlog of data will be analysed and published. Many thanks for your response to the SOS, Mark.

Footnote: A more detailed background to calibration and magnitudes can be found in articles in earlier Newsletters - Walker in 2010-4 and Blackford 2011-2.

Generating Model Light Curves – *Mark Blackford*

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Model light curves are used in a number of astronomical studies, including categorising supernovae, eclipsing binary and other variable star types. However, the catalyst for developing the procedure outlined below was a request from Stan Walker for help in finding accurate epochs of maxima from seasonal observations of Cepheid and RR Lyrae variables.

The basic idea is to gather a sufficient number of high quality observations of the target variable to allow a good approximation of the phased light curve to be drawn. This Model Light Curve (MLC) is then superimposed on a phased light curve of new observations. Any significant change in the variable's period will result in an offset between the MLC and new data.

Originally MLCs were generated and applied manually using tracing and graph paper, which was generally subjective and time consuming. Computers can do the job more quickly and accurately, so Stan wrote a Quick Basic program which he used successfully for many years. However, he thought it could be improved so put out a request for anyone willing to help.

I'm no computer programmer but have some experience with Microsoft Excel and the VStar program developed by David Benn for AAVSO (<http://www.aavso.org/vstar-overview>) and thought it should be possible to use these in an MLC fitting procedure. The spreadsheet I developed, and how it is applied, will be the subject of a following article. Here I will describe the first part of the process, generating an MLC with VStar, which will be illustrated using the short period Cepheid AG Crucis.

Step one is to obtain a set of 50 or more good quality observations of the target covering the full range of variability and with no large gaps in the phased light curve. One could make the necessary CCD or PEP measurements over a season or two, but there are alternative sources. The AAVSO International Database contains a wealth of data on thousands of variables, including AG Crucis, which can be retrieved through the Data Download page (<http://www.aavso.org/data-download>). There we see that the Auckland Photometric Observers Group made numerous UBV observations between 1982 and 1995 which could be used. Databases of the All Sky Automated Survey (ASAS) and other earth or space based surveys are potential sources as well.

A set of ASAS data acquired between February 2005 and July 2009 (Figure 1) was used for the following example. A dozen or so observations from this time span were rejected because they

were clearly discrepant, leaving a final total of 293 observations.

After importing the ASAS data into VStar we see the data plotted as shown in Figure 1. Next we perform a period analysis with the Date Compensated Discrete Fourier Transform function by selecting “DC DFT with Period Range...” from the Analysis menu. DC DFT identifies any periodicity present in the data but requires some initial boundary conditions to be specified, namely low and high period limits and resolution. We know the period of AG Cru is about 3.8 days therefore low period = 3, high period = 5 and resolution = 0.00001 are suitable.

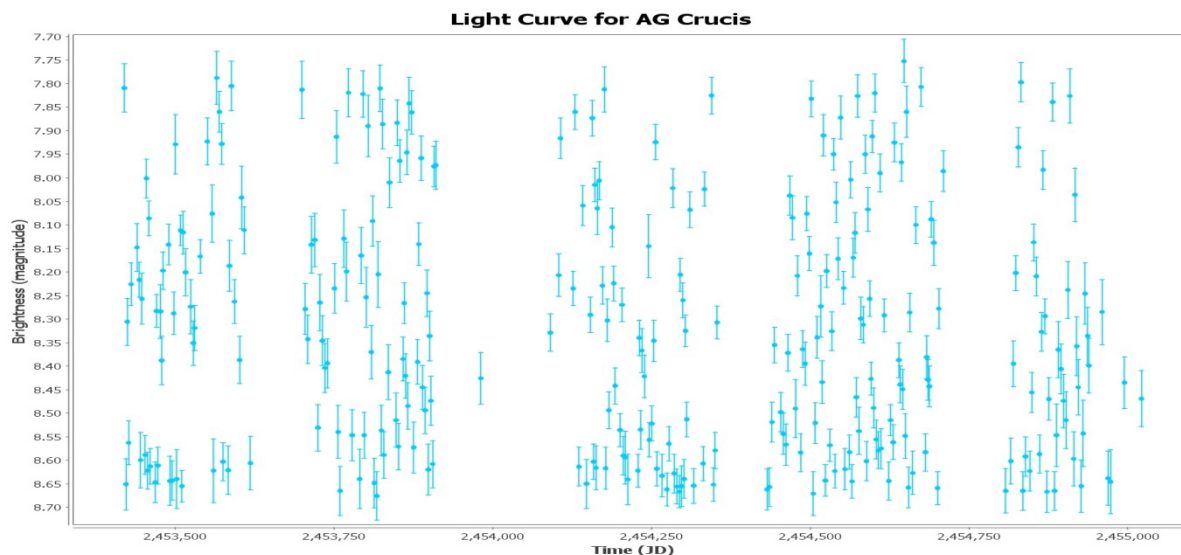


Figure 1. AG Cru ASAS data plotted in VStar as a function of Julian Date, seasonal gaps are obvious.

DC DFT displays the Period Analysis window which contains a “Top Hits” list of candidate periods with the top row representing the strongest periodic signal present in the data. Highlighting that row and clicking the “New Phase Plot” button produces the phased light curve shown in Figure 2.

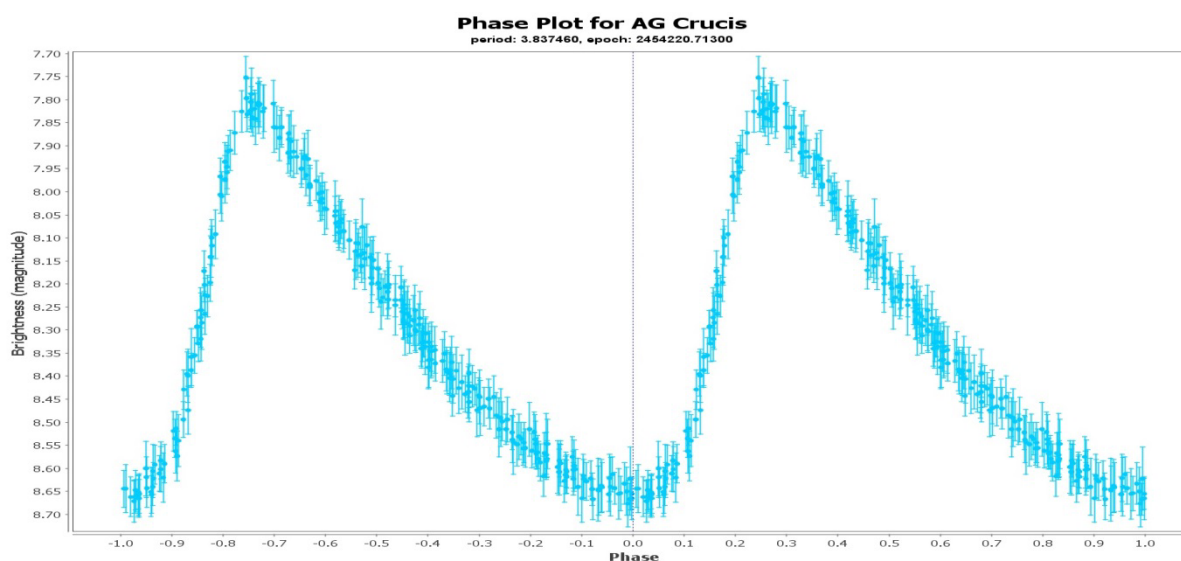


Figure 2. AG Cru light curve phased using the 3.837460 day period identified by the DC DFT routine.

The next step is to create the model light curve using a Fourier series approximation to the phased light curve. The basic concept is that any periodic curve can be represented by a series of sine and cosine terms. More accurate models require longer series of terms which are added by selecting higher numbers of harmonics of the basic period.

Figure 3 show a single harmonic model superimposed on the phased light curve. This is obviously a poor representation of the true light curve but adding several additional harmonics markedly improves the model. Figure 4 shows a model with five harmonics which accurately reproduces subtle humps evident in the phased light curve and would be an adequate MLC for AG Crucis.

Some variables may require a greater or lesser number of harmonics so a little trial and error may be required. Be wary of using too many harmonics because you'll end up just fitting noise in the dataset.

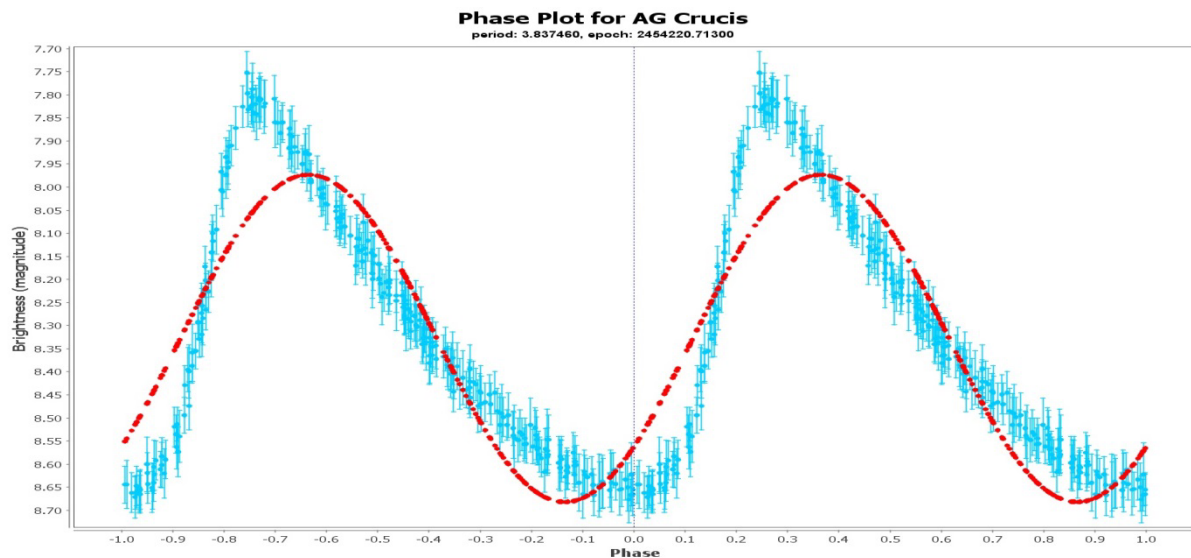


Figure 3. *Fourier series model with one harmonic superimposed on AG Cru phased light curve.*

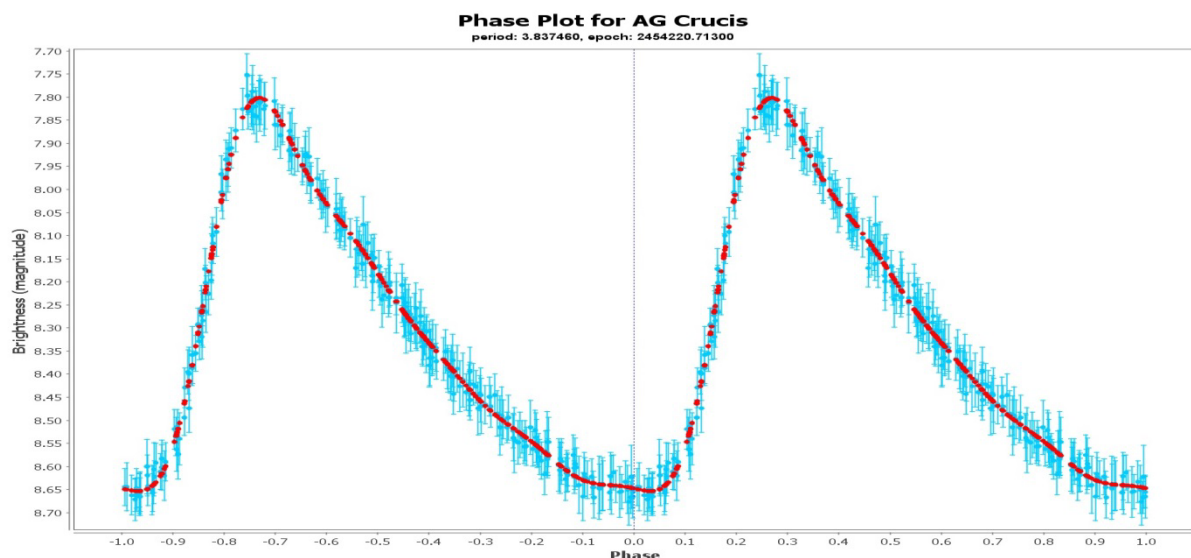


Figure 4. *Fourier series model with five harmonics superimposed on AG Cru phased light curve.*

Coefficients of the Fourier series can be viewed by selecting “Models...” from the Analysis menu. In the window that appears select the model with five harmonics and click the “Show Model” button to display the “Model Information” window (Figure 5).

The Fourier series equation is presented in three different ways, a standard mathematical notation, a form (nearly) suitable for copying into Excel, and one suitable for the statistical software package called R. Please note that the Excel expression needs to be copied into a text editor (e.g. Word) so a

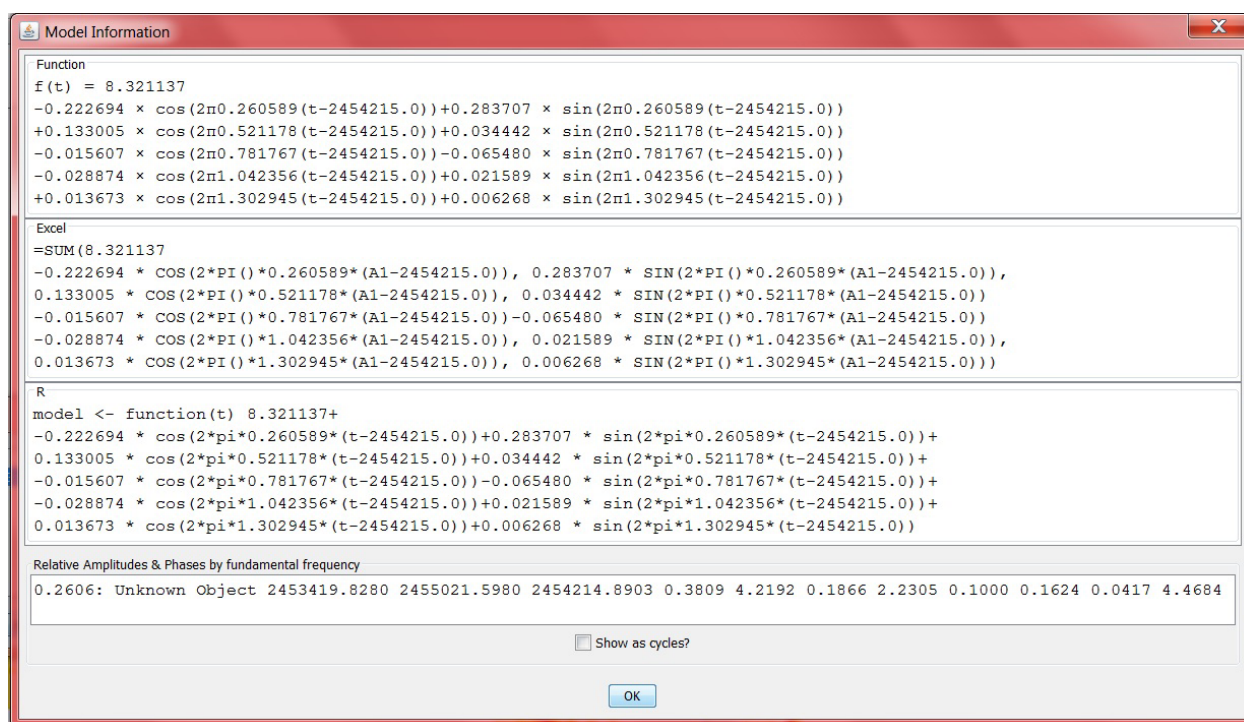


Figure 5. Fourier series equation and coefficients for the five harmonic model shown in Figure 4.

comma can be added at the end of each line (if not already there) except the last, and line breaks removed. The edited equation can now be copied into Excel. The equation will return a magnitude based on the Julian date (full 7 digits before the decimal point) entered into cell A1.

Now that the MLC equation is in an Excel compatible form we are ready to proceed to the task of finding epochs of maxima from seasonal observations of AG Crucis. But this will be covered in a future article.

Acknowledgements

I'd like to thank Stan Walker for motivating this work and Glen Schrader for many helpful suggestions. A special thanks to David Benn for his continued development of VStar and help in using it, especially the new user manual.

Southern Eclipsing Binaries Programme – *Tom Richards*

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So you think eclipsing binary observing is easy?

It has been a bad few months for observing. Very little data have come in to me, and that was all from Australia's east coast. We desperately need a wider longitudinal spread than that! Where are the kiwis?

The first goal in observing eclipsing binaries is to get is an eclipse. Yes, true. All of an eclipse, or as much as you can get in one night. Only by timing eclipses can we derive the light elements – period P and a zero epoch E0 (exact time of one eclipse).

So you've got to find out first which of our 150 or so targets is providing an eclipse tonight, near your meridian around your midnight so you can get a good long time series. To help with that, Margaret Streamer provides a data file for David Motl's excellent freeware *Ephemerides* program, downloadable from our website at Research > Eclipsing Binaries > Southern Eclipsing Binaries Programme. Even with that many targets, you may be lucky to have a well-placed eclipse on a given night. Figure 1 shows the target list for me, tonight. My midnight is 13h UT – only CE Scl is well placed.

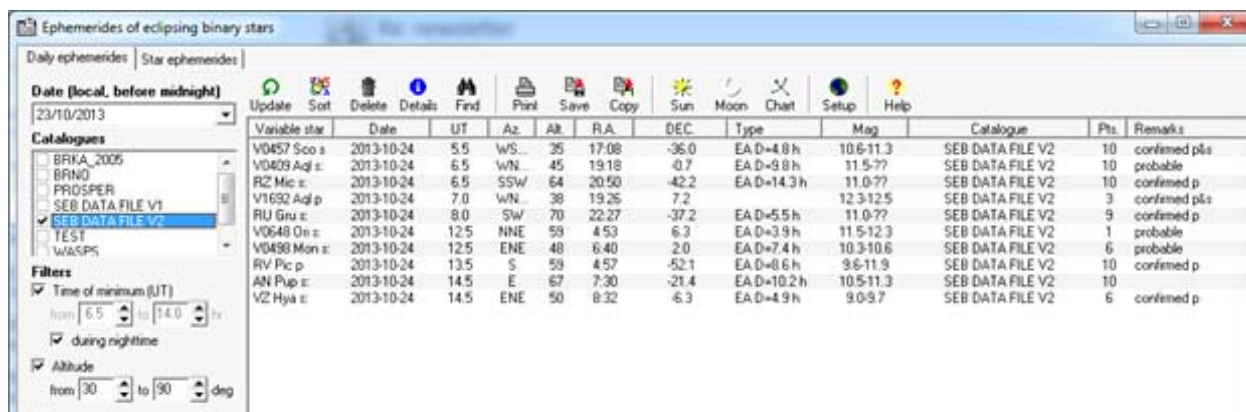


Figure 1. Ephemerides predictions for a typical night. ‘p’ means a primary eclipse, ‘s:’ means a secondary, possibly.

Our aim is to have four well-measured primaries before we’ll publish light elements. That incidentally is far more rigorous than a lot of published work. We’ve been at eclipse timing for about three years now, and we’ve reached that goal for only one or two of our binaries. More observers needed! Once we have our four primaries and light elements, we can look at secondaries, uneclipsed behaviour, and colour data. Then we’re well on our way to being able to model the system.

Eclipse disasters I have known

But, back to square two: you’ve carried out photometry on your night’s images and have an eclipse curve – usually far from perfect. Now you have to determine the moment of mid-eclipse. Eyeballing it is a measure (sorry) of desperation. Maybe you’d use it on the curve in Figure 2a with a generous uncertainty. Its only use is as a rough check on the light elements in the literature – in this case it showed they predicted eclipses hours later than reality. The trouble with that light curve is that observing started far too late (I relied on the bad prediction) and the seeing was initially atrocious. Incidentally all these light curves are mine – I wouldn’t embarrass other observers by showing their problem curves.

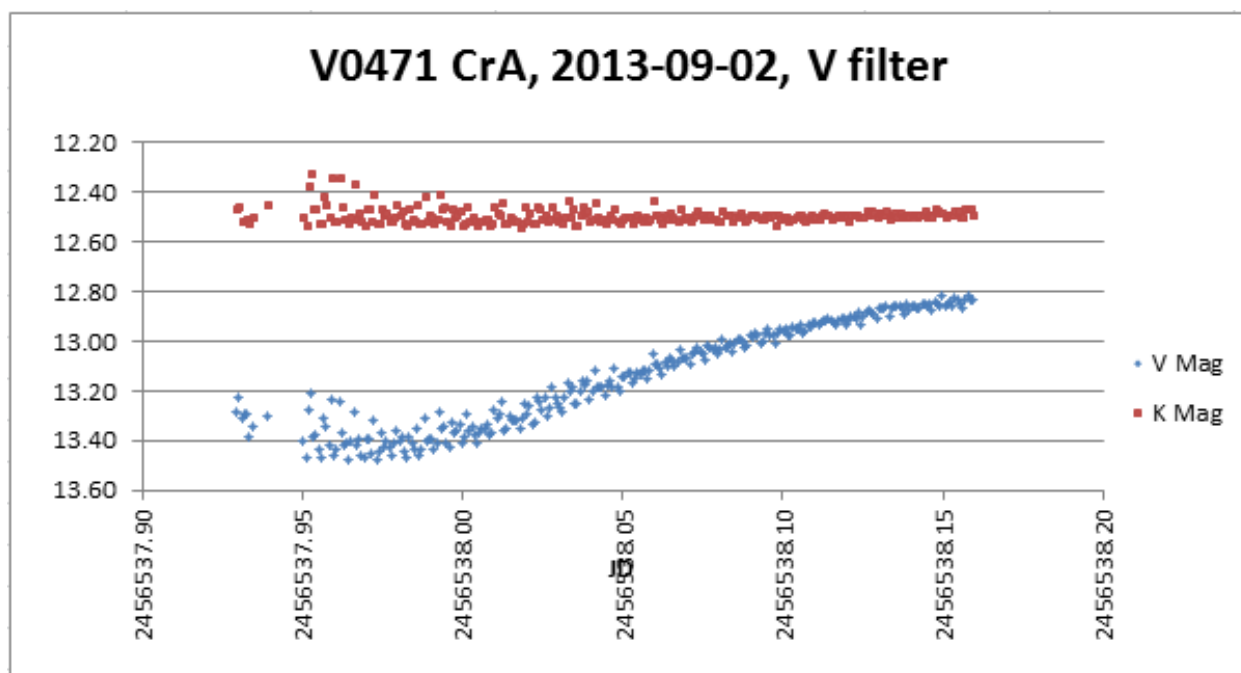


Figure 2a

Eclipse measurement is best done by an algorithm, not by you. Figure 2b shows a beautiful eclipse curve. There are two broad ways of finding the mid-eclipse point – both supported in the PERANSO software we use. One class essentially joins data points at the same magnitude on each

side of the eclipse with a horizontal line and finds its midpoint. In this way, since the eclipse is symmetrical, the midpoints form a vertical line marking the mid-eclipse point. That works beautifully with an eclipse like this one with hundreds of points on both sides of the eclipse to push down the errors. It doesn't work if the eclipse is not symmetrical. In that case you ask the software to fit a polynomial curve to the eclipse, and it reports where the minimum of that curve is.

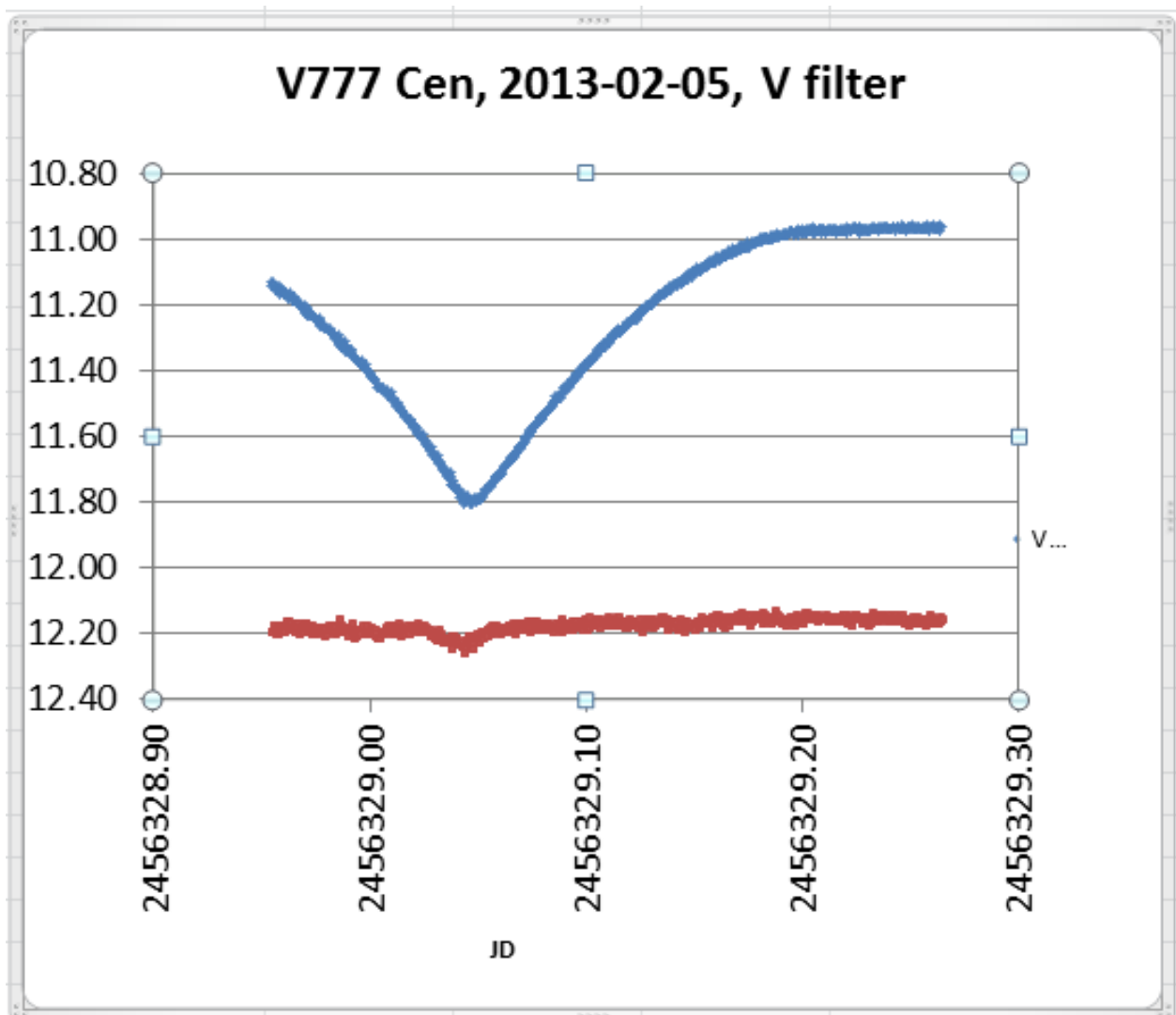


Figure 2b

Nevertheless, there's a serious problem in Figure 2b. The (red) check star seems to show a little eclipse at about the same time as the (blue) target star. Did it really, and if it didn't how do you explain that dip? Could the comparison star have brightened briefly? Unlikely. Was there a smoke drift from bushfires that preferentially darkened a bluer check star? Did whatever it was affect the eclipse curve of the target? At all events, our confidence in the measured minimum must go down.

Figure 2c (overleaf) presents another problem. The eclipse has a flat bottom – a sign of an enduring total eclipse. So where's mid-eclipse? The polynomial-fitting approach won't help, because if it fits well it won't have a single lowest point, and if it does it will be an artefact. And the chord-bisection approach will simply fail in the flat bit. My solution is to use chord-bisection but deactivate all the flat data points so I'm just measuring the two sides of the eclipse.

Figure 2d has real measurement problems. It's a very shallow eclipse, and because of the interruption only the curve below about mag 9.1 can be used. The very shallow sides mean chord bisections will have large errors, and also a polynomial's inflection point could be rather arbitrary.

Finally, how do you find the minimum in Figure 2-e? In this case, one of the stars is pulsating. If it's pulsating regularly, you can use a software process call pre-whitening (for some reason) to find

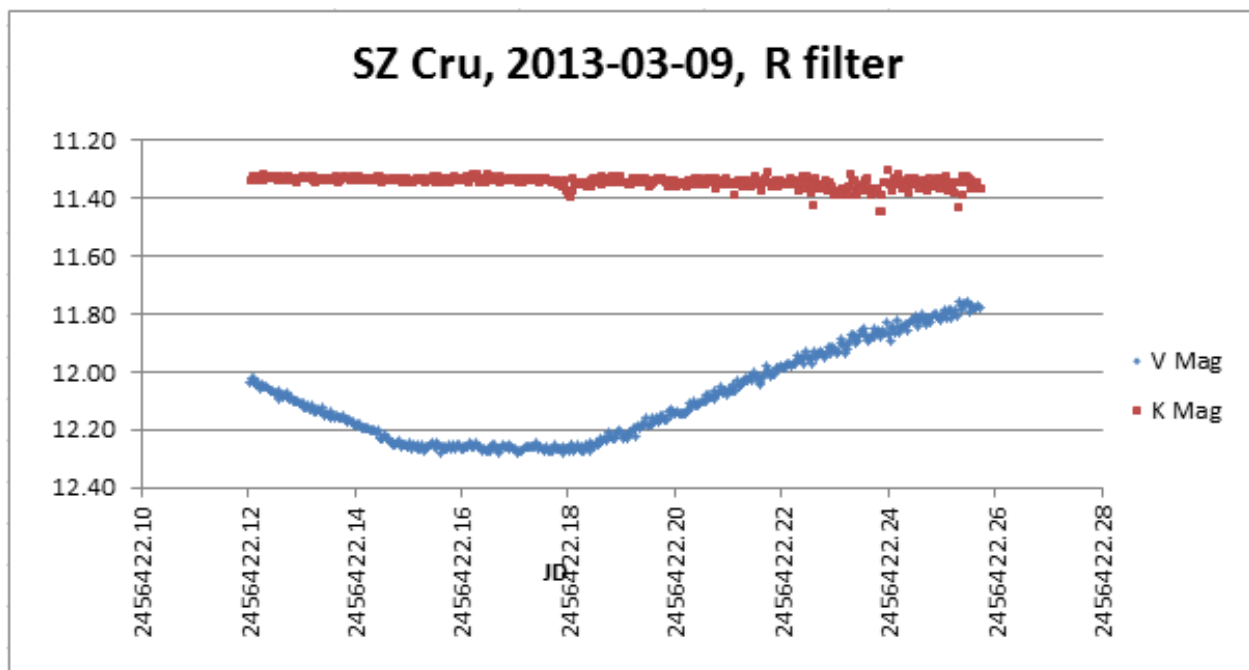


Figure 2c

the pulsation frequency and subtract that from the light curve data. PERANSO will do it, as well as other photometry analysis packages. If the pulsations are irregular, many frequencies perhaps, this turns into a nightmare.

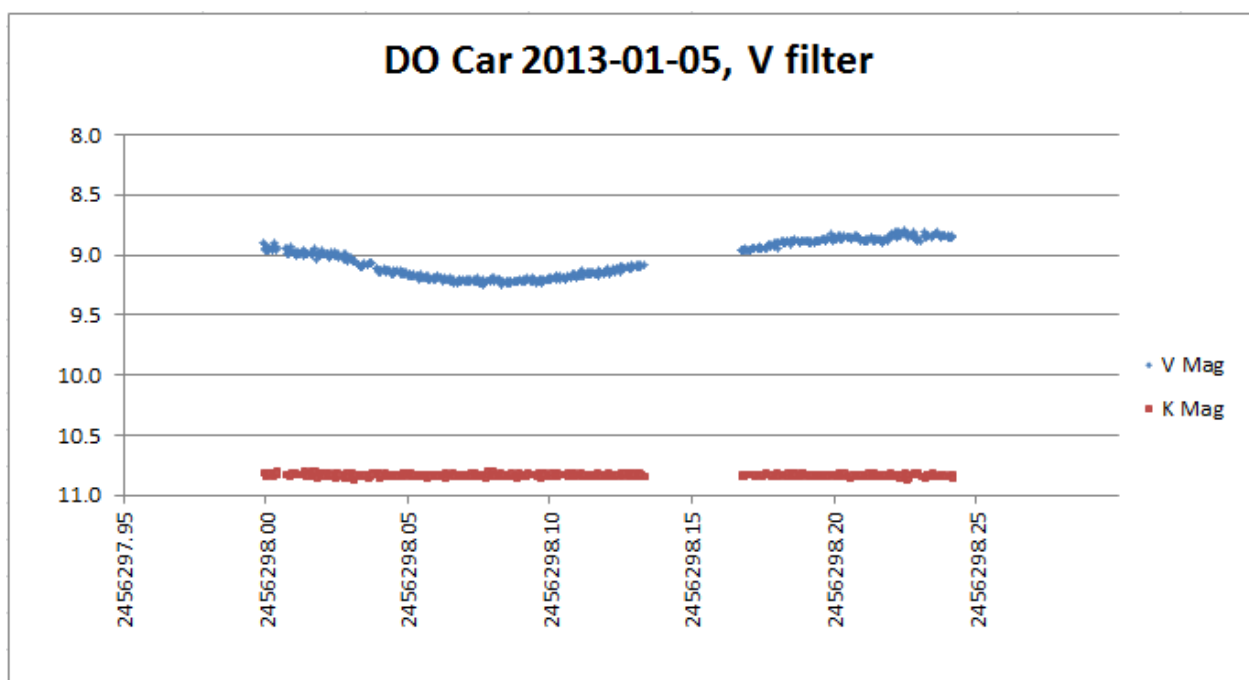


Figure 2d

Well, there are some of the joys of observing eclipsing binaries. You don't come across these issues in the refereed publications, because authors present results not journeys. But journeys are what we in the SEB group have to travel, and thanks to modern telecommunications we can travel together and help each other. The amazing thing is we've become quite good at solving these problems, and are keen to help others with the journey. So if your life is boring, join in!

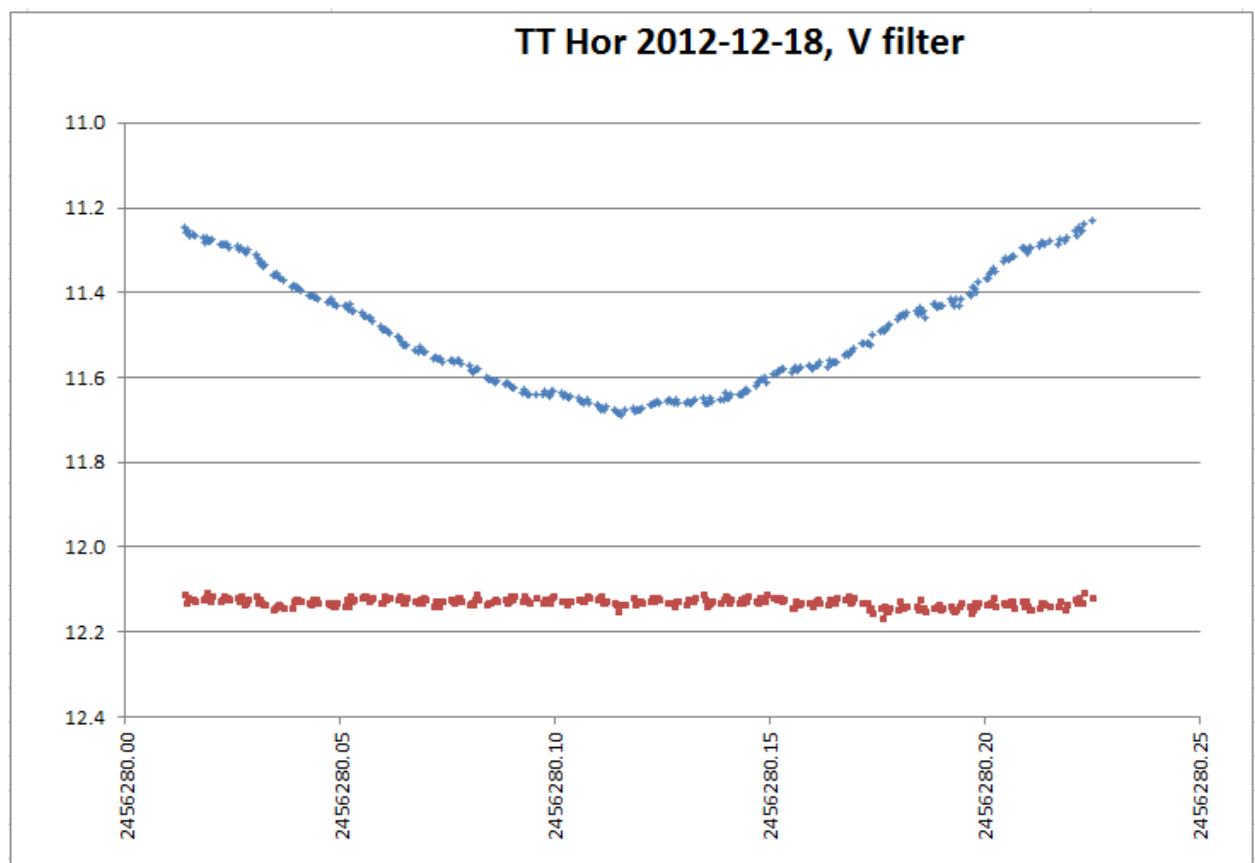


Figure 2e

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 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.

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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 and the copy deadline is the thirteenth of the month though earlier would always be appreciated.

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