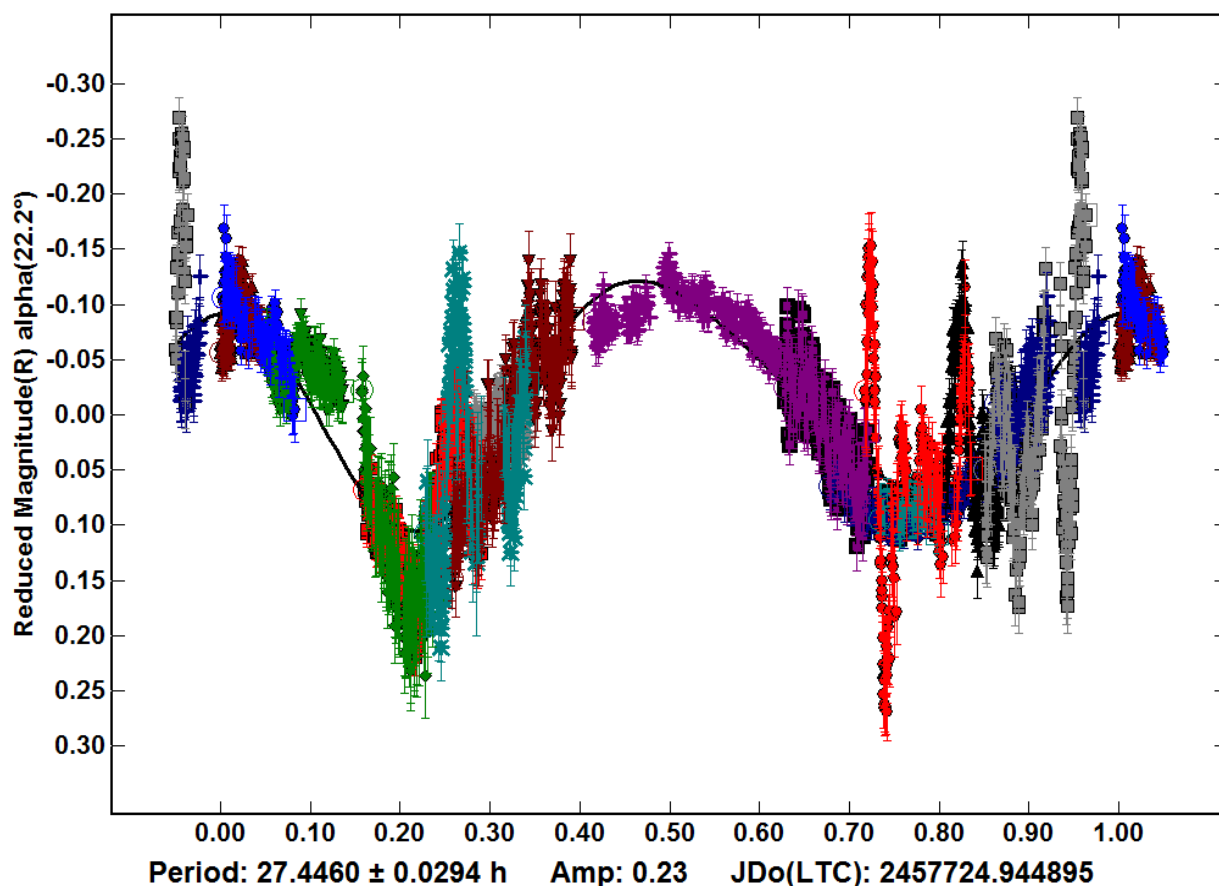


Phased Plot: 1139 Atami



Phased plot of the period of the asteroid 1139 Atami obtained by Carl Knight as part of his Pro-Am collaboration with astronomers from the Pulkova Observatory, St Petersburg. See article on page 18.

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Greetings from a very damp Waiharara in New Zealand's Far North. First we had a three month drought from mid-November, then in the last 60 days the gauge shows a total of 479 mm of rain. Global warming was predicted to produce extremes of weather and we seem to be getting those. But at least daylight saving has now finished here and darkness arrives at a reasonable time.



Some thoughts regarding the directorship. As most of you are aware I reluctantly took this on at the end of 2014 for what I stipulated was to be a three year period. This will end in December of this year. So perhaps a few of our members could give a little thought to what's involved in this and/or whether they'd like to be involved either as director or in some other more active role. I have some unexpected commitments other than astronomy at present so an earlier exit from the role would be welcome.

We have made some progress on the 2017 project involving the massive, multiple star system, QZ Carinae but this has highlighted that the abolition of a membership fee has resulted in considerable confusion as to who our members are and their interests and equipment. We'd like to involve a few more in this project. There are also many other projects where more cooperation would be very useful. And it certainly makes observing more enjoyable! So to rectify this we'll be circulating a large number of people shortly with a simple questionnaire linked directly to our membership register. No, we don't propose to institute a membership fee but we might suggest a small voluntary donation to keep a few aspects of the group running.

One of these projects involved V777 Sagittarii and this has turned out to be quite interesting although our chief discovery is not what we had planned. A draft paper has been circulated to participants and this should be ready for submission shortly. To understand the results I had to refresh my knowledge of celestial mechanics - those aspects related to the relationship between mass and orbital periods - and also a variety of mass/luminosity/temperature relationships. But the star deserves it - along with zeta Aurigae it seems to be the only example of a hot, blue star eclipsed by a non-variable giant or supergiant object.

RASNZ Annual Conference, 2017

The RASNZ Annual Conference is being held in Dunedin on 12-14 May and details, including papers to be presented, appear on their website. Regrettably I will not be there - May is always a busy time for me in other areas. For those interested the next conferences are scheduled - 2018 in Christchurch, 2019 at New Plymouth and 2020 in Wellington. Apart from New Plymouth these are easily accessible. Perhaps we can fit a Variable Stars South meeting with one of these.



Abstract

V1 is a bright red giant member of the southern globular cluster NGC 288. Observations made by Oosterhoff (1943) indicated semi-regular variations, but examination of his light curve, and a recent light curve from ASAS promise to expand our knowledge of the star.

History

V1 was discovered by Oosterhoff (1943), and estimates were made on 144 plates with the Franklin-Adams camera at Johannesburg. His estimates are tabulated as step estimates over an interval of 785 days, from JD 2425524 to 2426309. His conclusion is of semi-regular variations, with a period of 103d, ranging from 13.5-14.1p. No actual lightcurve is given. He provided a finder chart, showing the variable and two comparison stars. Modern positions are as follows:

V1	(J2000)	00 ^h 52 ^m 41 ^s .15	-26°33'27.3"	SPM 4.0
a	(")	00 52 27.27	-26 29 30.6	CMC14
b	(")	00 52 41.01	-26 33 37.6	CMC14

Published BV photometry for stars **a** and **b** is scarce, but I have accepted the following:

a	V = 13.35, B-V = 0.66	Derived from CMC14 r, J and Ks
b	V = 13.77, B-V = 0.90	Alcaino and Liller (1980). Photographic.

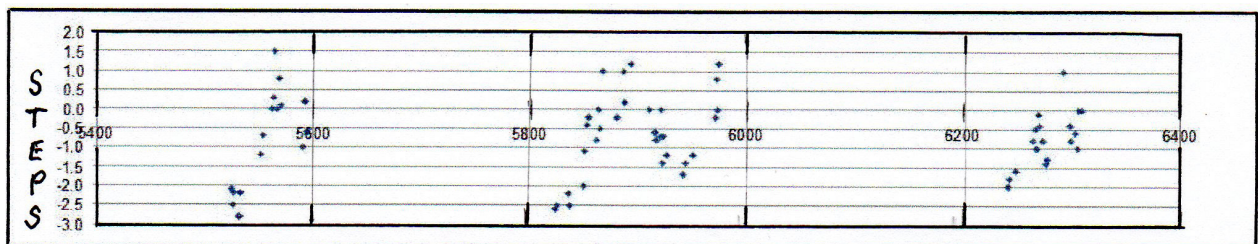


Fig. 1. NGC 288-V1. Photographic light curve from JD 2425524 to 2426309. Data points are by Oosterhoff (1943), who identified three maxima : JD 2425576, -5885 and -6292. His magnitude range is 13.5-14.1p; his observations were reported as step estimates, relative to stars **a** and **b**.

I have plotted Oosterhoff's step estimates as a light curve. (see Fig. 1). While much of the data is consistent with SR variability, there are very large gaps in the record. No doubt it was assumed that a number of maxima existed in the gaps, but missed due to seasonal factors. The total magnitude range however seemed consistent in the cycles which were observed. Oosterhoff himself noted that his estimates were uncertain as the image of the variable is in contact with other star images. He reported maxima at JD 2425576, 2425885 and 2426292.

ASAS-3 Lightcurve

See Fig. 2. This displays ASAS-3 measurements in V, spanning 3210 days between HJD 2451988 and 2455200. I consider only the points between 11.5V and 12.5V to be real measurements, of **V1** and **b** combined. Their separation is only ~10", and therefore a correction must be applied. Alcaino and Liller (1980) measured both stars photographically. Their results are :

V1 :	V = 12.57	B-V = 1.79	[Star 260 (ring 1)]
b :	V = 13.77	B-V = 0.90	[Star 257 (ring 1)]

ASAS 005241-2633.5 Light Curve (asas3)

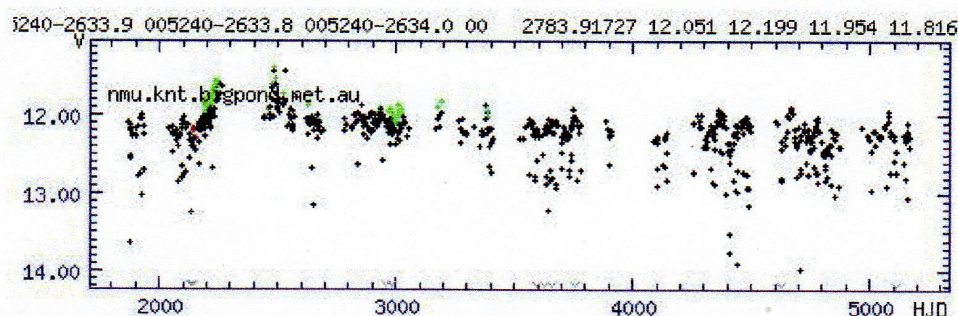


Fig. 2. Light curve for ASAS 005241-2633.5, a blend of NGC 288-V1 and “b”, lying 10” south. Most points considered to be real are concentrated in a band between 11.5V and 12.5V, rather than those <12.5V.

The extreme brightness on the ASAS lightcurve occurred on the following dates (comb. mag.), but it is difficult to discern any clear regularity.

HJD	V_Mag_0	V1 (corrected)
2486.8002	11.426	11.546
2529.70919	11.423	11.543

Minimum V is a little unclear, but if 12.50V (comb) is adopted this suggests a corrected magn. of 12.79V, for the variable alone.

There is another problem with the ASAS-3 data, the rapid cadence of many observations. Between HJD 2452188.66567 and 2452227.57891 there were 27 observations, almost one/day, while the observed variation was small, changing little around V=11.7 (comb). This cadence is not really appropriate for this type of variable. 5-day or 10-day means would be quite sufficient. This may be a future project, to re-analyse the ASAS data.

Conclusion

The work by Alcaïno and Liller (1980) shows that V1 is undoubtedly a member of the GC NGC 288. It sits on the extreme tip of the red giant branch of the Colour-Magnitude Diagram and is therefore unlikely to be a foreground star. The ASAS lightcurve, as downloaded, is not directly comparable with earlier work, possibly due to noise and contamination from background stars. There is scope for further work, to extract a cleaner lightcurve, to check the published period.

References

- Alcaïno, G. and Liller, W. 1980 *Astron. J.* 85, 1592
Hogg, H.S. 1973 *Pub. David Dunlop Obs.* 3,6 [3rd cat. of var. stars in globular clusters]
Oosterhoff, P. Th. 1943 *B.A.N.* 9,397

Congarinni Observatory – Part 2 – *Mark Blackford*

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Things have progressed since the first instalment of this series, but there's still a lot of work remaining before the observatory is completed. Several local builders were contacted but only one was interested enough to visit the site to discuss options. He seemed keen and organized for a concreter to pour the 5m by 5m observatory slab in late January.

We embedded plastic conduits between the edge of the slab and the two piers for power and communications cables. In retrospect I should have opted for larger diameter conduit because Ethernet and USB cables will be very difficult to feed through the existing conduit. I'll probably have to cut the connectors off one end of each cable before feeding them through, then crimp on new connectors.

Trips to Brisbane and Wellington delayed further work on the observatory until late February. While in New Zealand I caught up with Carl Knight for lunch at a café in Otaki. Carl offered some sage advice on observatory construction, particularly regarding wind shielding.

On returning to Congarinni I repeatedly tried to contact the builder to see about getting started with the observatory building but he failed to get back to me. So the decision was made to build it myself, with a lot of help from my mate Danny. He has some wood working experience, a lot of the necessary tools, and plenty of spare time as he'd retired a few months before me.



Figure 1. *Danny and I installing insulation foil to the west wall before attaching corrugated iron sheeting and lifting the wall into place.*

Of course more tools were required, along with lots of treated pine structural timber, screws, nails, corrugated iron, etc. So I got to know the local Mitre 10 and Bunnings staff very well over the following months.

The building is a basic stud wall structure 5m by 5m in size. The east, west and south walls are 2.2m high and the north wall is 2.7m high. Each wall was assembled flat on the slab then moved out of the way while the next wall was assembled. The West wall is very close to an adjacent water tank (Figure 1) so it had to be insulated and clad with corrugated iron sheeting before the wall could be lifted into position and dyna bolted to the concrete. The other wall frames could be installed first before adding the insulation and corrugated iron.

Having bought a new SBIG STT-3200ME CCD camera I was a bit impatient, so before the walls were completed I installed a Celestron CGEM mount and Orion ED80T CF refractor on the smaller of the two piers (Figure 2). Initial results are very promising but Cyclone Debbie and associated weather has limited observing to only a few nights so far.



Figure 2. *Building mostly erected, with one telescope installed.*

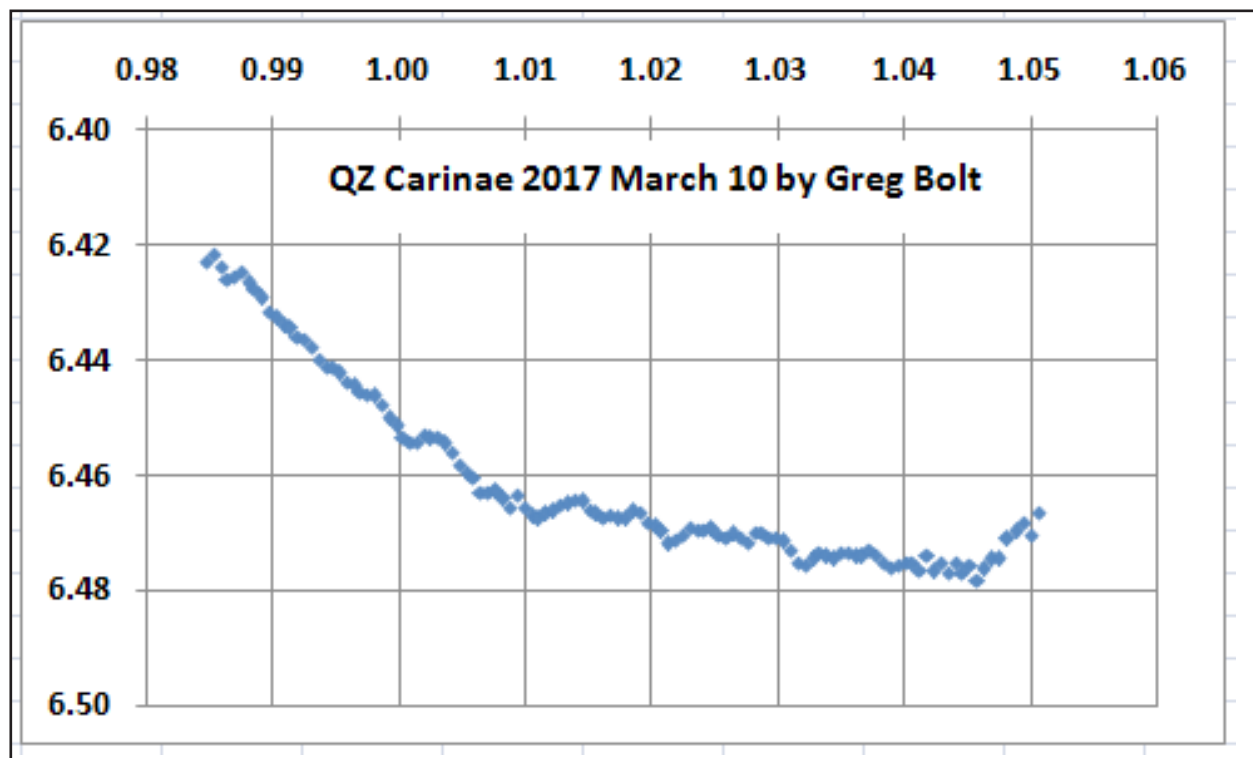
After finishing the east wall the next step will be constructing the gantry to the south (left in Figure 2) onto which the roof will roll. The ground to the south falls away fairly steeply so the gantry will be quite high, presenting a bit of a challenge to make it stable.

Stay tuned for instalment 3 in the next VSS Newsletter.

I have been working with Greg Bolt of Perth and also Mark Blackford near Sydney to establish the present time of the beginning of totality - contact two of the four. Below is a graph of Greg's measures on 10 March, 2017. The epoch is JD 2441033.084 and the period 5.99857. From this it appears that totality begins at phase 0.005 which is JD 2457823.1114. Quite clearly there is still a large light time effect caused by the position of the eclipsing pair in the mutual orbit of the two pairs of stars.

This allows calculation of various aspects of the eclipse as at this date. Bear in mind that they will change slightly over the course of the observing season. As well, the binary pair is now approaching us in its orbit so the observed times will be systematically earlier than these.

	10.3.2017	10.3.2018	10.3.2019
First contact - eclipse begins, previous JD	###.6915	###.6043	###.5170
Second contact - onset of totality	###.1114	###.0242	###.9370
Mid- eclipse O-C and LTE calculated on this	###.2314	###.1442	###.0569
Third contact - end of totality	###.3514	###.2642	###.1769
Fourth contact - end of eclipse.	###.7713	###.6841	###.5968
Longitude of mid-eclipse	94.536 E	125.939 E	156.342 E



These values are based upon Leung et al's fit to the original Marino & Walker data. Checking the validity of this fit by fully observing the light curve covering the total eclipse is the main goal of the project. The secondary eclipse is centred 2.999 days later but may well be slightly displaced as the eclipsing system might have a slightly eccentric orbit. The actual times and magnitudes of first and fourth contact will then allow a true value to be determined for the radii of the eclipsing stars—rather than the present calculated ones. This allows more reliable models of this pair.

All the VSS analyses to date have used HD 93695 as a comparison with the values 6.470, -0.130,

-0.600 and HD 93131 as a check, with values of 6.480, -0.030, 0.880. The first is similar to the values from Guide 9 as used in the table of comparison stars, the second star, a Wolf Rayet object, differs somewhat, mainly in the V value. Recommended CCD and DSLR comparisons appear below.

Observations and scheduling

Comparisons

	Identity	V Mag	B-V	Spec	Error T	Comments
	CCD Comps					
1	8626 2254	8.435	-0.043T	A0		
2	8626 2225	8.481	0.112T	O9		NSV 18500
3	8957 599	8.116	0.016T	B2		
4	8957 1017	8.434	-0.064	Oe	0.015	
	DSLR Comps					
1	8626 2061	7.769	0.385T	B0		
2	8626 641	7.308	0.219	B0		
3	8626 2052	6.792	-0.020	A0		
4	8957 2919	6.271	0.050	A0		
5	8626 2443	7.251	-0.028T	B3		
6	8957 3817	7.340	-0.062T	Oe		
7	8927 2047	7.981	0.064T	B2		
8	8613 2110	6.482	-0.098T	A0		
	Other Stars					
A	HD 93131	6.450	-0.017	WR	0.011	Auckland Check NSV 18488
C	HD 93695	6.469	-0.121	B5V	0.007	Auckland Comp NSV 4978

In this table the identity column is Tycho numbers or HD for the brighter stars. Other Tycho values are identified with a final T. The NSV designations may not be appropriate, many such labels of blue stars merely reflect poor transformations to the standard system.

Preliminary

What is required at this stage is for reliable V magnitudes of the comparison stars to be obtained. B-V can also be checked at the same time. The Auckland Observatory values of the main comparison star HD 93695 were obtained by interpolating repeated measures between an E Region each side and are very close to Guide 9 values derived from Bessell's transformations of the Tycho measures. It is a foreground B5 star and this spectral class does not suggest any reason for variability. Nor does the Tycho scatter of 0.007 magnitudes.

Most of the other selected comparisons are highly reddened hot stars at a similar distance to QZ Carinae, ~7500 LY. As such the Bessell transformation values may contain slight inconsistencies which can result in values for comparisons differing by up to 30 millimag. If measures are made only on either the ingress or egress these different values will affect the determination of the light time effect and also distort the observed mean light curve we're determining. An error of 30 mmg during ingress/egress affects the light time effect by 0.078 days. So the whole set must be tied in to the HD 93695 values.

I hope that Greg Bolt and Simon Lowther can measure the CCD stars, Mark Blackford the DSLR ones. As the B-V of QZ Carinae is heavily reddened at ~0.13 similarly reddened stars are the best comparisons. Thus the A0 stars, which are probably foreground objects, are less suited than the O and B stars - but can be used if necessary.

Observations for the project

For the purposes of obtaining the eclipse shape and the times of the four contact points filtered V measures alone are adequate. How accurate will this be? The colour differences will be <0.0300 and the B-V CCD correction of probably <0.050 per magnitude will give <15 mmags. Since HD 93695 is $\sim 24'$ from QZ, stars 1, 2 and 3 might be better for CCD measures. The best DSLR stars are 3, 4 and 8 but are farther from QZ. We await final values. The large B-V correction inherent in DSLR work should not affect the V filter data much but this will become clear when the measures are made using any new values. Do not use other catalogue values for any of these stars. The derivation and the accuracies are uncertain and we cannot afford to let errors arising from this affect results.

There is also something to be learnt from the long standing methods of measuring CVs, in particular the unfiltered measures of the CBA people. Here they make zero point corrections and occasionally modify the scale as well to build a composite light curve. We may need to apply this technique to some extent.

The manner in which Greg's measures were made will interest the CCD people. He stopped his 250mm telescope down to 85mm, used a slight defocus (many years ago Mike Bessell suggested this to me as more accurate—but at least it gets rid of saturation) and 10 second exposures. There were over 2400 of these and I then used a 19 point running mean to smooth the data. The collecting area is $1/9$ of the full aperture so this is equivalent to 2×10 seconds unstopped.

This all makes Excel run rather slowly so if anyone out there has an easy way of summing the measures in Excel so that there are only 120 data points, each an average time and magnitude of 20 images it would be useful. These would then be discrete points with 200 seconds resolution which is adequate and much easier to manipulate in graphs.

Even allowing for the slightly earlier occurrence of events at midwinter—15 cycles from 10 March is 0.01875 days or 27 minutes—the first observable contact one point will occur well to the east of New Zealand. So we need someone in South America. But NZ and Eastern Australia can define the ingress slope. Perth should be able to see the end of totality and a little of egress but we need some in South Africa and perhaps in between. There are three months to set these things up. If anyone has ideas for this let me know.

There is no reason, due to the colours involved, why measures could not be made in B alone. This would help the stopping down problems with larger aperture telescopes.

The primary eclipse does not appear complicated and about four sets of measures of the second and third contact points would be adequate—probably for two or more hours each side. The secondary eclipse seems a little more erratic and we may need more measures of this. As for distribution of resources, the ingress curve is best observed from New Zealand or even farther east, the egress curve from Perth and Southern Africa.

One other point—Grant Christie is interested in looking for small, short period variations in HD 93131 so if you can include this star in the image without prejudicing the main project it would be useful. Only on longish runs, however.

Astrophysical aspects

Let's examine what we're trying to achieve overall. The system is very complex with four massive stars in two pairs with periods of 20.73 for the more luminous pair, 5.99857 or so for the eclipsing pair. The eclipses are shallower than expected since that pair contributes only about 40% of the light. As well, there are stellar wind effects and the elliptic orbit of the more massive pair might cause light variations, particularly at their periastron. This might have an identifiable signature which we could detect with sufficient good quality out-of-eclipse measures.

The contact points one and four are difficult to determine as the rate of magnitude change from ingress/egress to the sinusoidal aspect variations is quite small. But this is important in determining the sizes of the components by actual measurement, rather than model fitting.

In practice, however, the slopes of ingress/egress can be determined with a sufficient number of mea-

tures during these two phases. Similarly, the shape and amplitude of the aspect effects will also be found with enough good measures. So we have as a target observations to provide an overall light curve of QZ Carinae. How much of this can we observe in a season? At any one point in midwinter astronomical darkness covers 11 hours, although nautical darkness is an hour longer. At present we have sites from Perth to Auckland, 59 degrees of longitude, although Whakatane or Gisborne would extend that by 3 or 4 degrees. So we can measure 75% of the light curve effectively. A South African or South American site would fill in the missing six hours.

Completion of a truly accurate light curve would then allow a more reliable determination of the orbital curve of the two pairs. The normal approach to this is to time eclipses but with this system the total eclipse duration is 1.08 days—from the original data fit, although this may not be quite correct—and 0.24 days of totality. So the only way to define this 50 year orbit is to fit accurate measures to an accurate light curve. The historical measures now available can then be reworked once this light curve is obtained.

Another question relates to the possible ellipticity of the orbit of the eclipsing pair. There are suggestions in the fit of the available measures that the secondary eclipse may be displaced by a few percent in phase. Resolution of this is another step forward.

Summary

In some ways the least important part of the light curve is the period when it's fully eclipsed. The critical times are the four contact points but first and fourth, defining the beginning and end of eclipse, are the difficult ones. So we should concentrate on obtaining as much of the ingress and egress curve as possible, but always with either the start or end of totality included and an hour or so of minimum. A few runs through the phases of totality on good nights will define this adequately and also indicate whether there is anything unusual about the light curve.

Uneclipsed measures will allow a reconstruction of the first and fourth contact points to a reasonable degree of accuracy.

Once reliable values have been established for the recommended comparison stars the data may need reworking. If you have any doubts it is quite acceptable to reduce measures as differential to a certain comparison star. They can then be adjusted once its values are determined.

To keep up to date with the situation and to avoid over observing of some features I would appreciate a copy of all measures. Eventually they will all go onto the International Database. But it's normal not to do this immediately for ongoing projects, particularly as in this case some magnitude changes might be in order.

I note that there are some good measures during the current season on the International Database, by the times from Southern Africa—probably by David Blaine.

There are not yet enough measures to circulate a current light curve but in a few weeks something will appear on the website and the Google group.

Don't hesitate to contact me about any aspects of this project—also I'd appreciate copies of measures so the light curve can be updated.

Part IV – Can we exploit colours?

In Parts I and II of this series (this *Newsletter* 2016-3 & 4) I discussed the variety of information you could derive from just looking at the light curve of an eclipsing binary, eschewing maths, computers and just applying a bit of careful thinking. Some information you can derive in this way is recognising if an eclipse is total, obtaining the relative sizes of the stars from total eclipses, recognising if the stars are relatively close to each other, the tidal distortion of very close pairs, stellar limb darkening; and, if total, using depths of the two eclipses to derive relative brightnesses and luminosities of the two stars, and hence their relative radii. In Part III (this *Newsletter*, 2017-1) I applied what we'd learned to the strange case of V477 Lyr, the white-dwarf binary at the centre of the Abell 66 planetary nebula in Lyra (not the Ring Nebula as I mistakenly said).

To finish off this series I'll look at what we can learn from the colour of an eclipsing binary system. Simple arithmetic here can take us a long way - I'll relax our no-maths requirement to that extent. Then we'll see how adding that information to what we learned in Parts I and II can take us a lot further. But beware...

“Assumption is the mother of all fuckups” – apocryphal, CIA?

The colour of an eclipser

Basic square-1 astrophysics tells us that from the colour of a star we can infer its temperature and spectral type. The commonest way of expressing a star's colour is its B-V colour index. This mainly ranges from around -0.3 mag for the bluest, hottest stars to around +2.0 for the reddest, coolest. It is not difficult to find the B-V mag of a star online: go to SIMBAD (<http://simbad.u-strasbg.fr/simbad/>) and in the Basic Search field type the star name, e.g. “HS Aur”, “alf Cru” or “HD 10916”. Then look for the B and V magnitudes. You may also find the spectral and luminosity classes listed. If not, there are tables correlating the B-V magnitudes, spectral type, and effective temperatures for stars of the different Morgan-Keenan luminosity classes such as giants (class III) and main-sequence or dwarfs (class V). See (Cox 1999), - hereafter Cox - which needs to be on the bookshelf of every variable star researcher.

The listed B-V mags for very many stars are unreliable, and you may prefer to obtain your own observationally. This does mean observing your target star and some comparison stars in the same field using B and V filters, and transforming your results. That's a process not discussed here but see <https://www.aavso.org/transforms-everything-you-need-transform-your-ccd-observations>.

The B-V mag of an eclipser can change significantly with orbital phase. Consider the extreme example of a small bright hot primary that gets totally eclipsed by a much bigger redder secondary. But the B-V mag listed in SIMBAD or elsewhere takes no account of that. Catalogued B-V mags can only be assumed to be the value obtained when the stars are uneclipsed and side by side, at peak flux (phases 0.25 and 0.75). So a phased curve of the B-V mag can tell you a lot more – but you'll have to obtain it.

NSV 1000 – an amateur effort

Figure 1 shows my phased B-V curve for the contact binary NSV 1000 which oscillates between B-V = 0.70 and 0.78. The median of 0.74 makes “it” a G8 with effective temperature 5310K. The variations from that in the plot are actually too small to get entries in the usual photometry tables such as in Cox, where I obtained these figures.

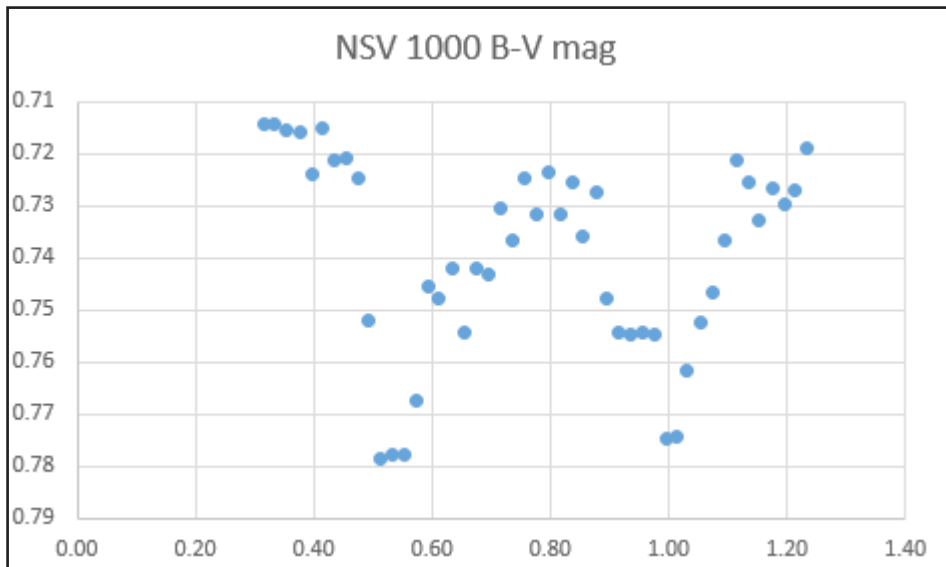


Figure 1. Phased curve of $B-V$ colour index for NSV 1000. Pretty Hill Observatory, Kangaroo Ground, Victoria.

But let's try to list the assumptions we're making here. First, we're looking up a table for single isolated stars. Secondly the table was for normal main-sequence stars (luminosity class V), and stars in interacting binary systems are definitely not normal in either of these two ways. Thirdly, until we somehow find out how much of each star is eclipsed or occulted at each minimum, we don't know how much each contributes to the change in $B-V$. However you have to work with what you've got, so let's accept these assumptions and see where our understanding of light curve shapes (as in Parts I and II) can take us when augmented by colour data.

In Figure 1 the system appears coolest at phases 1.0 (primary minimum) and 0.5 (secondary). See Figure 2 which shows a preliminary model of the system I have derived in BinaryMaker 3 (Bradstreet 2005), using my B and V data. (Col Bembrick is currently working on refining this model.) At those phases we're seeing the backside of one star or the other, indicating they are cooler than the area of the neck joining the pair. That may be due to a reflection effect or turbulence where the photospheres join, but that's speculation.

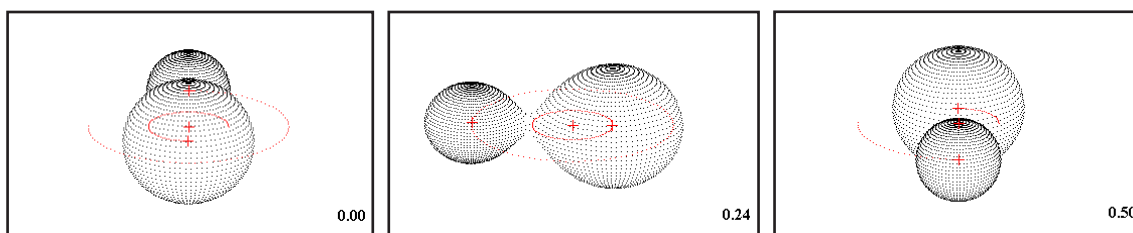


Figure 2. Preliminary model of NSV 1000, seen at phases 0.0, 0.24 and 0.5.

Beyond that, the $B-V$ data doesn't really help in understanding this system, except to indicate it's fairly cool. $B-V = 0.75$ corresponds to a G8V star, but we can't conclude (since it's not a single star) that its spectrum is G8 or that its class is V.

Maybe we can push colour data further if we look at detached EA systems, where we can treat each star as "normal". A fine example is HS Aur.

HS Aurigae – a well-studied system

We have very complete information on this system, including radial velocity curves. The information presented here is from the online CALEB database (Bradstreet 2004); the original paper is (Popper *et al* 1986) – hereafter Popper. See Figure 3.

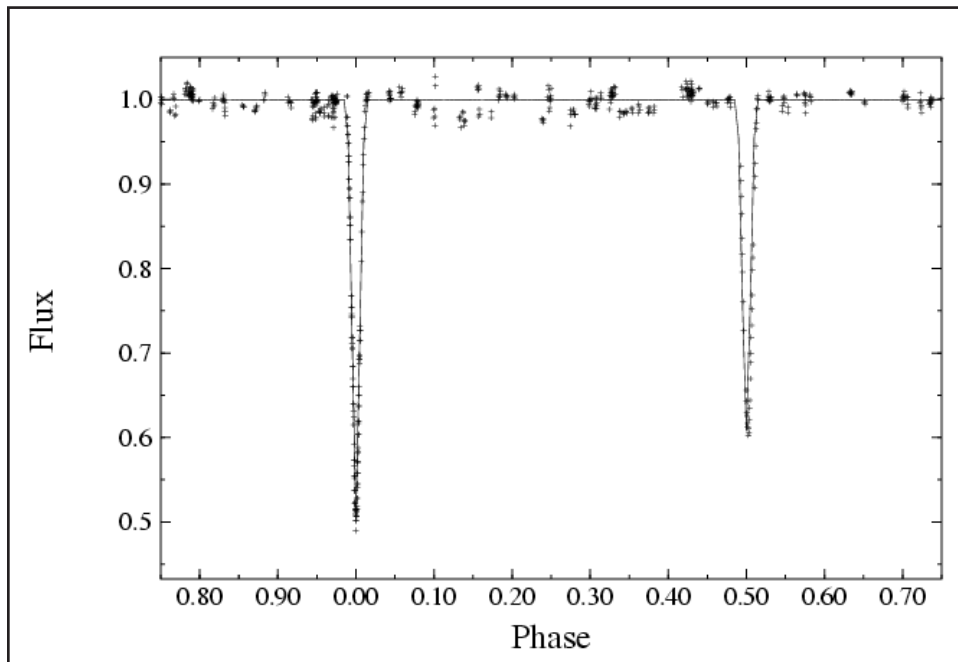


Figure 3. *V* light curve of the detached binary HS Aur.

SIMBAD tells us its B-V mag is +0.8. The table in Cox tells us a star with that B-V mag is a K0 star with effective temperature of 5150K, *if* it's a main-sequence star. By comparison if it's a supergiant it's spectral class is G0 but effective temperature is about the same. To pin it down, let's apply those figures to the more luminous star of the pair, and say it's main-sequence, since most stars are. Then, again from Cox, we can obtain some absolute astrophysical data: its mass is 0.79 that of the Sun, and its radius 0.85 of the Sun.

What about the secondary star? The depth of the secondary eclipse is ~75% of the primary, so (see instalment II, *Newsletter* 2016-4), its surface brightness (flux per unit area) is ~75% of the primary. So it's cooler. It's possible to calculate its temperature (using Stefan's Law) using the relative brightness and the temperature of the primary. It comes to 4800K, which assuming again it's class V we obtain a spectrum of K2 and B-V = 0.91. The tables in Cox then give a mass of ~0.75 Sun and radius ~0.8 Sun.

Those calculations went beyond the remit of this series of articles, to avoid arithmetic. But it's interesting that by using standard correlation tables, some basic physics and arithmetic we can leverage our qualitative analysis of light curves, together with knowing just the B-V magnitude, to derive some absolute astrophysical parameters of the stars.

To check all this, let's compare our results with what Popper *et al* worked out – see Table 1. They had spectra and radial velocity data to pin these parameters down properly, so we can take their results as reliable. Rows in yellow show where our estimates differed by >10% from Popper's.

Table 1. Table of properties of the detached binary HS Aur. It compares the ones we have derived by light curve inspection plus B-V, with Popper. Subscripts 1 and 2 refer to the primary and secondary stars respectively.

Parameter	Us	Popper
T_1 (K)	5151	5346
T_2 (K)	4800	5200
Spectrum_1	K0	G8
Spectrum_2	K2	K0
Mass_1 (Suns)	0.79	0.898
Mass_2 (Suns)	0.75	0.877
Radius_1 (Suns)	0.85	1.005
Radius_2 (Suns)	0.8	0.874

Checking assumptions and reaching conclusions

Considering the methods we've used, Table 1 shows a pleasing result. The discrepancies can be explained by our assumptions. We assumed first that these are main-sequence stars. This is confirmed in Popper (who incidentally used V and R photometry, no B so no B-V). Yet while our assumption turned out correct here, it is a very imprecise one. For a start the main sequence is broad vertically and stars with $B-V = 0.8$ have a luminosity range of $\sim 6:1$. And horizontally, stars anywhere from G0 to K5 could have the same luminosity, making inferences from brightness ratios to relative diameters rather shaky.

Also, the correlation of colour index with temperature is imprecise, and stars with $B-V = 0.8$ can vary in temperature by a couple of hundred degrees. You need detailed spectra to gain more precision. The truth is that tables as in Cox present of necessity an aura of undeserved precision which can make you think you can get more leverage out of knowing a B-V magnitude than is the case. Secondly, B-V magnitudes are subject to interstellar reddening aka extinction, which increases the B-V value and particularly affects B. There are tables for interstellar reddening, but they are rather generalised. Much better to rely on a spectrum, which is how you work out the amount of reddening towards your target anyway.

How reliable is the main-sequence assumption anyway? With detached binaries that have never interacted it's fairly probable, since most stars are on the main sequence. That made HS Aur safe. But many binaries with light curves like Algol (the EAs) are interacting, like Algol itself; so you can't be sure just from recognising an EA light curve. EBs (Beta Lyrae type) being very close are interacting, if only to distort the pair gravitationally. And EWs (W UMa type) are certainly interacting. So even if you place such stars on the main sequence by assumption or by their spectra, you can't assume they behave like a "normal" star in that position. And as often as not, their spectrum will place one or the other off the main sequence.

I think the conclusion from this is that it is a poor idea to rely on catalogued B-V magnitudes to draw any but the broadest conclusions about your target system, even if it's an EA like HS Aur – let alone a contact binary like NSV 1000. You don't even know if they're corrected for interstellar extinction, and probably are not. Instead, you really need to know the spectral and luminosity classes of your system. If you find a reference to them for your system, check it out, because often they may be based on the sort of weak reasoning we pursued for HS Aur. It's worse if you use that B-V data as a basis for modelling an interacting binary system.

To sum up, I think the sort of non-arithmetical, marginally physical, reasoning we've used in this series of articles is useful heuristically, to outline to a range of broad features of the binary system. These are not the sort of results you'd want to base a refereed paper on, but they would be very useful as guides, starting points and sanity checks in more detailed investigations you may undertake, e.g. modelling. Similarly B-V data can be a rough guide to temperature. If you're not aware of the sort of features you can derive in this way, you will commence your modelling in a dauntingly wide parameter space. More, a model you derive (which is likely one of many that fit your light curve well) should simply be checked against these qualitative conclusions we've made. If it doesn't square with them, why not?

The final point is that to do a good job you really need good spectra and radial velocity curves. But you have to work with what you've got, and that's just photometry. It would be a pity if you didn't let your photometric analyses see the light of day in a refereed paper, just because you lacked the data the professionals can (sometimes) get. Perfection is not for this world, nor is completeness, and your imperfect incomplete data and results still add to our knowledge and will inform subsequent workers on your chosen stars.

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Abstract

Visual observations of the 2015 eclipse of BL Tel are presented and summarised. These indicate the date of mid eclipse was GJD 2457262.4 (+/- 0.5 days), an interval of 778.4 days since the previously observed eclipse of 2013. The duration of this eclipse was 75 days and a minimum visual brightness of magnitude 9.2 attained. Based on these observations, a mean period of 778.06 days is determined from the 15 cycles since this program commenced in 1983. The next eclipse of BL Tel is expected to be centred near GJD 2458040 (2017 Oct 13).

Introduction

BL Tel has been the subject of a long term visual program by members of the Variable Star Section of the RASNZ and more recently the new VSS, Variable Stars South. Eclipses of this long period Algol system have been monitored since 1983 with the aim of establishing the date of mid eclipse for each observable event and to establish the basic parameters of each event.

The eclipse of 2015 is the 11th event to be successfully observed, covering 15 cycles or 11,671 days.

Visual observations and results

A total of 99 visual observations were obtained between May and October of 2015 with 80 of these concentrated on the actual eclipse event. Numerous CCD and DSLR measurements were also obtained during this interval but this report will deal primarily with the visual data as part of the long term visual program on BL Tel. The ten observers who provided visual measurements were Alexandre Amorim, Jon Brandie, Lucas Margo Da Silva, Robert Evans, Andrew Pearce, Juliana Pontes, Antonio Padilla Filho, Renato Pereira, Paulo Reis Fernandes and Peter Williams. Five electronic observers to monitor this eclipse were David Benn, Mark Blackford, Terry Bohlson, Arne Henden and Peter Starr.

The visual observations have been plotted as daily means in the light curve shown as Figure 1. Here, single observations are shown as open circles while daily means of 2 or more observations are indicated by solid circles.

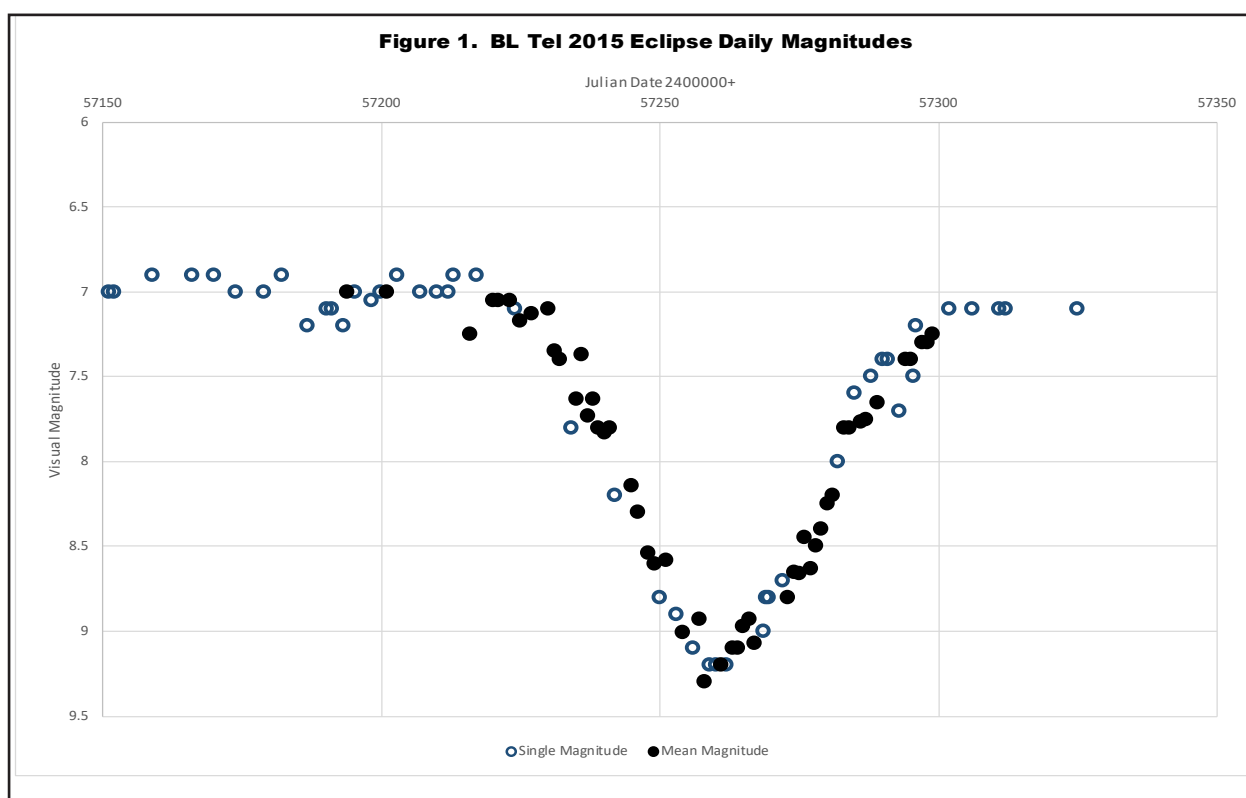
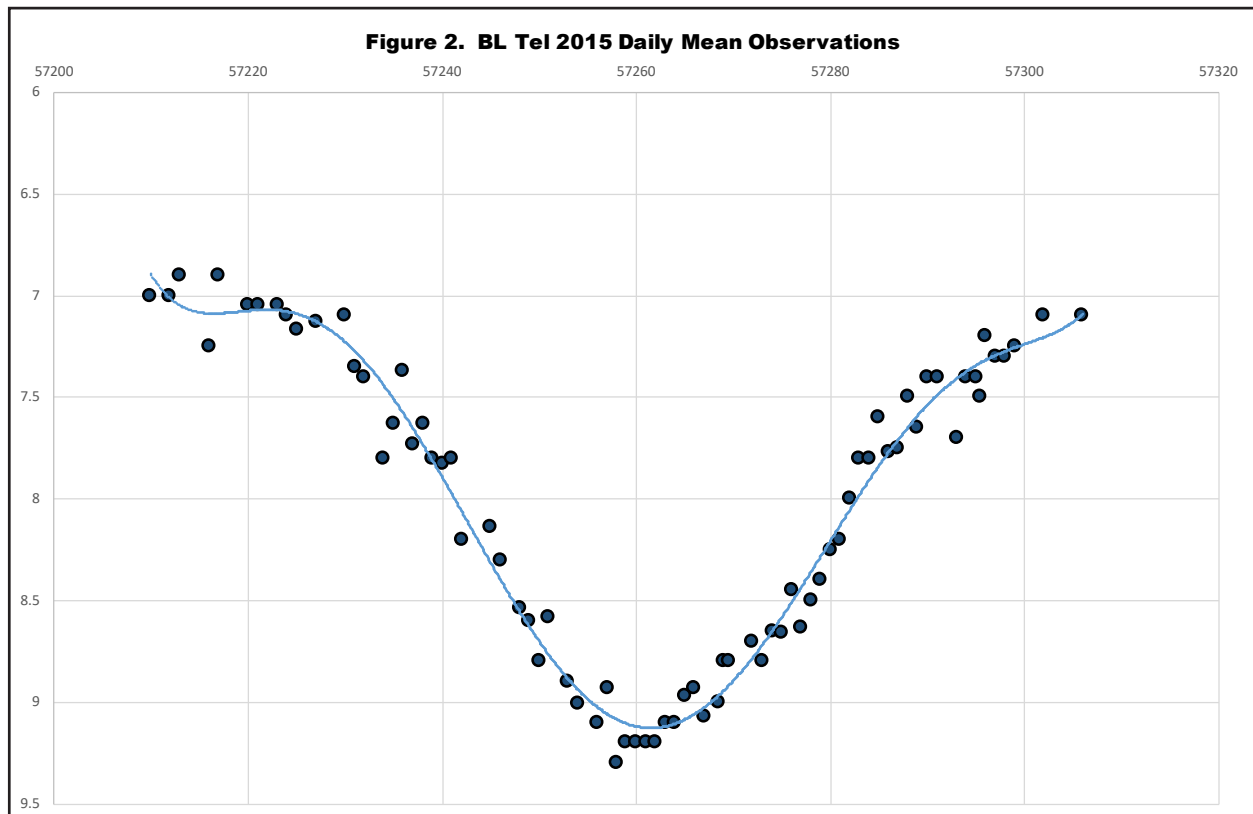


Figure 2 shows the eclipse light curve to which a 6th order polynomial has been added and the date of mid eclipse measured directly from the light curve. As has occurred in previous eclipses, the onset of eclipse is initially very gradual while rate of decline and recovery shows clear differences. The date of mid eclipse has therefore been measured as the mid-point between decline and recovery curves at magnitude 8.5, around 0.7 magnitude above minimum brightness.



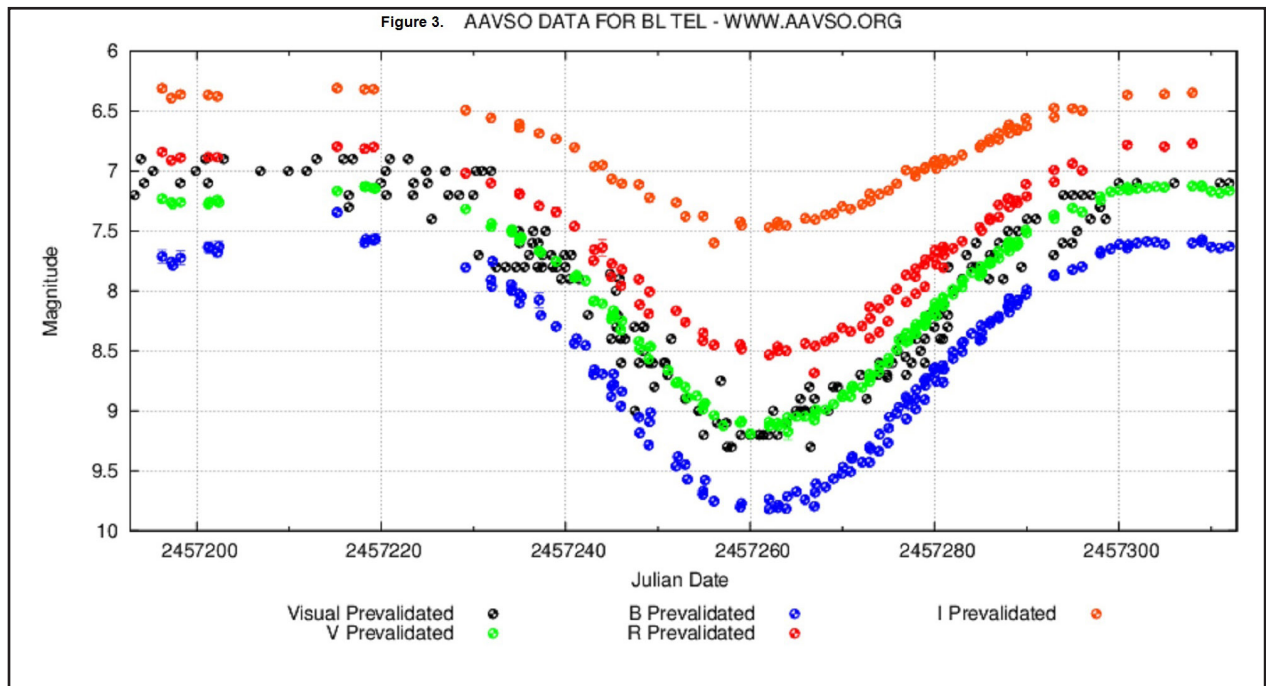
The date of mid eclipse has been determined as GJD 2457262.4 (± 0.5 days). No heliocentric corrections have been applied as this is deemed unnecessary due to the nature of the visual data. This is an interval of 778.4 days since the previous eclipse.

The 2015 eclipse appears to have been total with both the visual and electronic observations suggesting a flat bottom light curve where BL Tel remained at a near constant brightness for some 6 days. As mentioned above, the actual time of decline onset is not always clear but it appears BL Tel faded to minimum over 35 days while the recovery took marginally longer at 36 days, giving a total duration of 71 days for this eclipse.

With completion of the 2015 event, 11 eclipses have now been successfully observed as part of the current visual program. This available visual data now covers 15 cycles of BL Tel, yielding a mean period of 778.06 days over 11,670.9 days.

This mean cycle is, however, somewhat subjective as consecutive eclipses of BL Tel have been shown to vary by several days from the mean period. The goal of the visual program therefore remains to monitor the eclipses and determine the basic parameters of each eclipse over the long term. A summary of the 11 observed eclipses 1983 through 2015 is presented in Table 1.

Multi-colour photometry of the 2015 eclipse is shown in Figure 3, this light curve produced by the AAVSO Light Curve Generator (V1) using data submitted to the International Astronomical Database. It is pleasing to see this data being obtained and made available as it provides the opportunity for further study of the BL Tel system beyond the scope and goals of the visual program and electronic observers are encouraged to continue their monitoring of future eclipses.



Conclusion

Visual observations of the 2015 eclipse of BL Tel indicate mid eclipse occurred on GJD 2457262.4 (± 0.5 days), 778.4 days since the date of the previously observed eclipse. Total duration of this eclipse was 71 days and a minimum magnitude of 9.2 was attained. Based on these observations the next eclipse of BL Tel is expected to be centred near JD 2458040 (2017 October 13) when BL Tel will be well placed in the early evening western sky.

Acknowledgements

All observers both visual and electronic are thanked for their observations and ongoing interest in the BL Tel eclipse program.

Table 1

BL Telescopii Eclipse Summary calculated relative to catalogue elements JD 2434692 +778.1 days.

Year	Observed	Calculated	O-C (Days)	Mag	DurationInterval from (Days)	previous (Days)
1983	2445591.5	2445585.4	+6.1	8.60	57.0	-
1985	2446369.5	2446363.5	+6.0	9.60	65.0	778.0
1987	2447144.5	2447141.6	+2.9	9.30	63.0	775.0
1992	2448703.0	2448697.8	+5.2	9.20	58.0	779.3 (1558.5/2)
1994	2449481.0	2449475.9	+5.1	10.10	62.0	778.0
1996	2450256.0	2450254.0	+2.0	8.90	65.0	775.0
1998	2451034.5	2451032.1	+2.4	8.96	56.0	778.5
2000	2451812.5	2451810.2	+2.3	9.60	68.0	778.0
2011	2455702.0	2455700.7	+1.3	9.50	57.0	777.9 (3889.5/5)
2013	2456484.0	2456478.8	+5.2	9.5	58.0	782.0
2015	2457262.4	2457256.9	+5.5	9.20	71.0	778.4

Mean period over 11670.9 days (15 cycles) = 778.06 days.

Disclaimer

Not knowing the science of asteroids quite so well (bit of an understatement) what follows is perhaps more narrative than science.

Background

VSS was approached by Pulkovo Observatory, St Petersburg, Russia who were looking for observers to help them with research on binary asteroids.

At the time my V filter had hazing issues again and as only an Rc filter was required, I decided to take up the challenge.

My contact at Pulkovo throughout has been Eugene Sokov. His online accademic profile is available here: https://www.researchgate.net/profile/Eugene_Sokov

The research goals

- Improve ephemerides.
- Detect eclipses and occultations especially of the primary components and their moons.
- Deduce the morphology of the components from the light curves (cf. Warner, B. (2006) §11.11).
- Determine the Tholen (1989) class of the components.
- Improve the quantity and quality of the published work.

First steps

The first asteroid I was given to take photometry of was 2121 Sevastopol. The next two asteroids I was given were 4963 Kanroku, and 1139 Atami.

Getting to grips with a dim object ($R_c \text{ mag} < 15$) with a 2.9-ish hour primary period of rotation I tried to keep to a cadence set by two minute exposures. My first surprise was how much noise asteroid observers are prepared to tolerate. For the dimmer targets, 2121 Sevastopol and 4963 Kanroku, I was only getting a SNR of around 25. I enquired as to the project's minimum acceptable SNR and was advised that any SNR over 10 would be good! (Sokov, E. (2016) personal email correspondence).

Observations like everything in the never ending Spring of 2016 were hampered somewhat. However I did manage a number of nights with sequences of several hours.

Comparison of stellar and asteroid photometry

The asteroid light curves are noisy as surface albedo and morphology changes as the components individually rotate and orbit one another. This is in stark contrast to the stellar light curves I am most familiar with.

Comparison stars need to all be reddened solar colour indices ($0.5 < B-V < 0.9$) – i.e. like the reddened sunlight reflected from an asteroid. My confidence in the light curves only improved by examining the derived magnitudes for the comparisons over the sequences and ensuring that the SD of the comparison magnitudes was no worse than ± 0.02 (cf. Warner, B (2006) §10.1). I also pruned obvious outliers.

Where a comparison star did not meet the basic quality requirements I rejected it and in a couple of cases completely redid the photometry from the sequence with better (generally SNR) comparison stars.

After all of that I relied on the feedback from Eugene. Within the constraints of language differences and Eugene's academic workload, he has been a source of excellent advice and encouragement.

Results

2121 Sevastopol

I managed to capture two occultations of background stars by 2121 Sevastopol and received some excited correspondence on the topic. The occultations were unexpected and are indicative of the ephemeris of 2121 Sevastopol needing some work.

The primary period I have found is 2.9351 h for 2121 Sevastopol by FFT in MPO Canopus (Figure 1). NASA JPL Small-Body Database Browser (2017a) has 2.90640 h.

As Simon Lowther has pointed out (Central Star Party January 2017) the suggested accuracy of the plots in MPO Canopus (± 0.0016 h as in Figure 1) is somewhat ambitious and my advice was that the claimed precision should be treated with some scepticism. However, the period of rotation of the primary component is around the time stated by the NASA JPL Small-Body Database Browser (2017a).

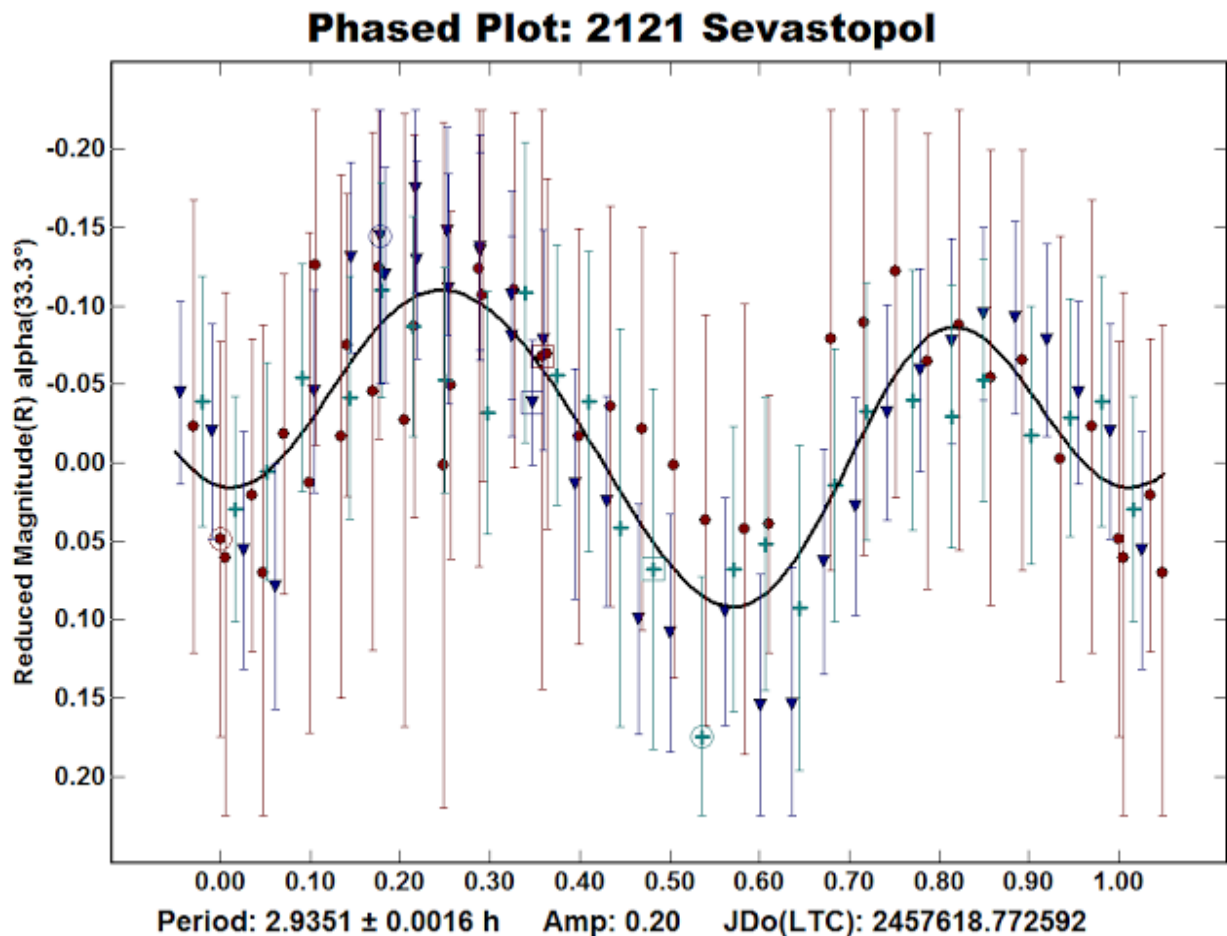


Figure 1. 2121 Sevastopol phased plot, period by FFT binning 3 (MPO Canopus)

4963 Kanroku

4963 Kanroku received the least attention due to the dreadful Spring of 2016. Four sequences were taken. There is insufficient data in what I have alone for a period determination or a meaningful light curve.

Eugene Sokov has given some indication of significant results are in the pipeline for Kanroku. When I know more I will report on those results.

1139 Atami

1139 Atami has received the greatest number of observations. It has been in the vicinity of Orion and is as of the date and time of this article, farther east past Procyon.

The light curve obtained of 1139 Atami is incredibly busy and remains (Figure 2) so after the process

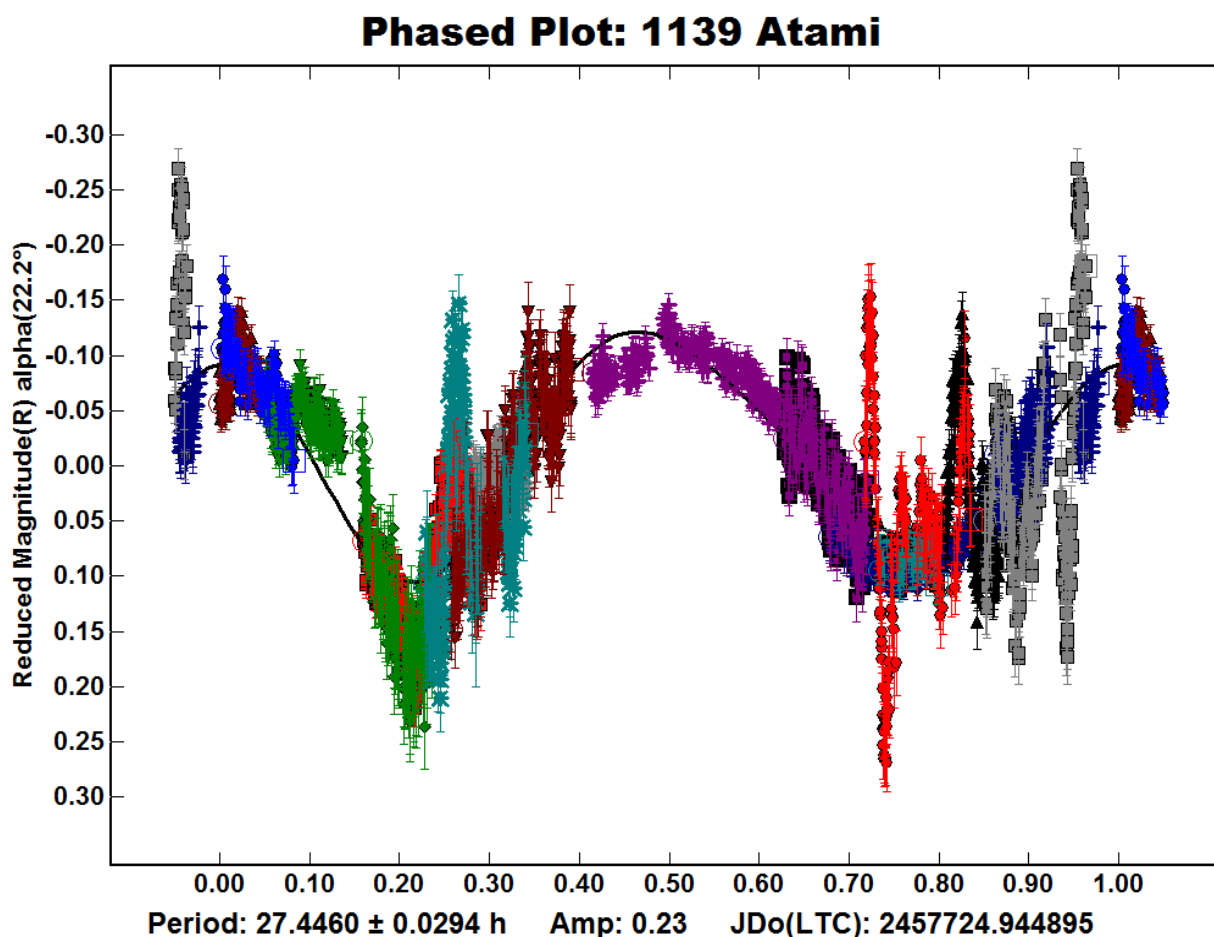


Figure 2. 1139 Atami Phased Plot, Period FFT (MPO Canopus)

of checking the comparison stars and pruning outliers, indicating real features in the light curve.

One caveat that I submitted to Pulkovo was the last two sequences of data were cloud affected and the quality checks made indicate borderline data. I submitted the data anyway along with the determination I made of the primary period which over the course of the summer zeroed in on the period held by the NASA JPL Small-Body Database Browser (2017b).

Eugene Sokov was particularly complimentary (Sokov, E. (2017) personal email correspondence) of my analysis of 1139 Atami.

ACM 2017 poster paper

Asteroids Comets Meteors 2017 (ACM 2017) was held in Montevideo, Uruguay between April 10 and 14. A poster paper was presented there from our work: Di Sisto, R. et. al. (2017), *New determination of physical and orbital parameters of 2121 sevastopol binary asteroid*.

I was very generously named a co-author. I was admittedly bemused to see among all the very august sounding professional observatories, there was mine, RD 1, Bulls – I fear the tour won't nearly be so grand!

The paper presents the following results:

- 9 observations of eclipses and occultations – four of the satellite by the main component, five of main component by the satellite.
- Colour indices (CI) of 2121 Sevastopol were obtained:
 $B-V = 0.91 \pm 0.20$ (cf. Sun 0.656 ± 0.006 – Gray (1992))
 $V-R = 0.49 \pm 0.10$

$$R-I = 0.38 \pm 0.08$$

- The Tholen taxonomy class has been determined from the CI. The CI suggests the components belong to Tholen's S (silicaceous) class. This is further corroborated by the albedo of 0.248.
- Taking the diameter of the main component to be 9.32 ± 0.04 km and the Tholen spectral class S, model light curves of 2121 Sevastopol considering the size of the components and a density of 3.2g/cm^3 (cf. Earth 5.514g/cm^3) best match the observed light curves.
- Given the NASA JPL dimensions (primary at odds with the 9.32 km above) of the components at 8.736 km and 3.54 km diameter respectively, the masses assuming the density found above are:

Main component: $1.11708 \times 10^{15}\text{kg}$ (cf. Earth $5.972 \times 10^{24}\text{kg}$)

Satellite: $7.433 \times 10^{13}\text{kg}$

Still to be determined are:

- Is the satellite orbit prograde or retrograde?
- What is the exact inclination of the satellite orbit? There is evidence this may vary.
- Satellite orbital period then is somewhere between 37.048 ± 0.001 h if prograde and 37.153 ± 0.001 h if retrograde.

Future directions

More asteroid observations are of course welcome. This leads to having to make some decisions about my observing programme. I wish to remain a variable star observer predominantly.

I've been asked if I could do some exoplanet observations. This fits very well with an area of observing that I am keen to learn and dovetails nicely with the project now under way in VSS. When I have more guidance on targets from Pulkovo I will pass it on to the group as a whole.

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Percy, J. R. and Deibert, E. 2016. *Studies of the Long Secondary Periods in Pulsating Red Giants* JAAVSO Volume 44, 2016

Abstract

We have used systematic, sustained visual observations from the AAVSO International Database and the AAVSO time-series analysis package Vstar to study the unexplained “long secondary periods” (LSPs) in 27 pulsating red giants. In our sample, the LSPs range from 479 to 2,967 days, and are on average 8.1 ± 1.3 times the excited pulsation period. There is no evidence for more than one LSP in each star. In stars with both the fundamental and first overtone radial period present, LSP is more often about 5 times the former and 10 times the latter. The visual amplitudes of the LSPs are typically 0.1 magnitude and do not correlate with the LSP. The phase curves tend to be sinusoidal, but at least two are sawtooth. The LSPs are stable, within their errors, over the timespan of our data, which is typically 25,000 days. The amplitudes, however, vary by up to a factor of two or more on a time scale of roughly 20–30 LSPs. There is no obvious difference between the behavior of the carbon (C) stars and the normal oxygen (M) stars. Previous multicolor photoelectric observations showed that the LSP color variations are similar to those of the pulsation period, and of the LSPs in the Magellanic Clouds, and not like those of eclipsing stars. Although our results are suggestive of rotational variability, there are several arguments against this. So the cause of the LSPs remains unknown

Axelson, R.A. and Napier-Munn, T. 2016. *The High Amplitude delta Scuti Star AD Canis Minoris*. JAAVSO Volume 44, 2016.

Abstract

The high amplitude delta Scuti star AD Canis Minoris was studied by photoelectric photometry (PEP) during one night in February 2011 and by digital single lens reflex (DSLR) photometry during seven nights in January and February 2016. Nine light curve peaks were captured, eight of them by DSLR photometry. A review of the literature enabled us to tabulate 109 times of maximum since 1959, to which we added 9 times of maximum from our data, thus creating the largest dataset to date for this star. Assuming a linear ephemeris, the period of AD CMi was calculated to be 0.122974511 (± 0.000000004) d, almost identical to that quoted in earlier literature. We constructed an observed minus computed (O-C) diagram which exhibited a quasi-sinusoidal shape, and fitted a weighted model characterised by combined quadratic and trigonometric functions. The fit indicates that the shape of the O-C diagram is attributable to the effects of a slow increase in the pulsation period of AD CMi at a constant rate, and the light time effect of a binary pair, confirming the results from previous authors, and updating most of the coefficients of the equation for the fitted model. The values of all of the coefficients in the function are statistically significant. The rate of increase in the pulsation period of AD CMi was calculated from the entire dataset to be $dP/dt = 6.17 (\pm 0.75) \times 10^{-9}$ d yr⁻¹ or $dP/Pdt = 5.01 (\pm 0.61) \times 10^{-8}$ yr⁻¹.

Stubbings, R. and Simonsen, M. 2016. *UY Puppis—A New Anomalous Z Cam Type Dwarf Nova*. JAAVSO Volume 44, 2016.

Abstract

The defining characteristic of Z Cam stars are “standstills” in their light curves. Some Z Cams exhibit atypical behavior by going into outburst from a standstill. It has previously been suggested that UY Pup had been a Z Cam star, but it was ruled out due to its long-term light curve. However, in December 2015 UY Pup went into outburst and unexpectedly entered into a short standstill instead of returning to quiescence. Furthermore, UY Pup exhibited additional unusual behavior with two outbursts detected during its standstill. After this standstill UY Pup made a brief excursion to a quiescent state and slowly rose to a longer and well-defined standstill, where it again went into another outburst. Through comparative analysis, research, and observational data of UY Pup, it is evident and thus concluded that it is indeed a Z Cam star, which renders it one of only four known “anomalous Z Cam stars.”

About

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

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

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

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

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

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

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

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