



Victoria observer Rod Stubbings has every right to be pleased with himself. He has recently submitted his 200,000th visual observation to the AAVSO. For an interview with Rod see page 24 of this issue.

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From the Director – *Tom Richards*

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VSS Meeting at NACAA – Easter

We now have a full and interesting programme for the VSS Colloquium (or Symposium or Meeting – take your pick) in Brisbane. (In the last Newsletter I referred to it as our inaugural symposium, forgetting that was in Wellington in 2009. A senior's moment?) We meet on Friday April 6th as a curtain-raiser to the NACAA conference. All registration can be done through the NACAA website, <http://www.nacaa.org.au/2012/about>.

Below is the draft programme. As befits a meeting of this kind most presentations are strongly oriented towards open discussion, with tutorials as well as the canvassing of issues and problems faced in variable star work. This should make for a lively and interactive day! See you there.

Speaker	Title	Duration	Abstract
SESSION 1			
David Benn	VStar: the next generation	60 mins	Vstar, the free, open source variable star visualisation and analysis tool has expanded and matured since the NACAA 2010 workshop. New features, bug fixes, and user interface changes will be covered and some of the uses to which it has been put will be summarised. Planned future development will be outlined. Attendees may find it useful to bring their laptops with Vstar (download free from http://www.aavso.org/vstar-overview)
Mark Blackford	How to get started in DSLR Photometry	30 mins	Surprisingly good photometry is possible using a basic DSLR camera and telephoto lens provided appropriate procedures are followed. DSLRs are well suited to imaging the relatively under observed bright low amplitude variables that are difficult for visual and CCD observers to study. Usable exposure times range from a few seconds for untracked cameras to several minutes for cameras on tracking mounts. Hardware and software considerations and factors influencing the choice of target variables will be discussed. Examples of image calibration and photometric measurement procedures will be given. Variable Stars South currently has two projects utilising DSLR cameras and would like to encourage more people to contribute to these. Audience participation during the presentation is encouraged.
SESSION 2			
David Moriarty	CCD Photometry Contributions to the SPADES Project: 1 Updating GCVS Ephemeris Elements	20 mins	The search for planets around detached eclipsing systems (SPADES) is a project to which I have been contributing since May 2011. Several of the target stars that I observed did not show any change around the times when minima had been predicted in ephemerides using the GCVS elements, and for many of those for which minima were observed, the times differed from predictions. In order to prepare for productive observing schedules in the future of this > 5 year research programme, I aimed to check and, where necessary, update the ephemeris elements in the first season of observations. As an example, the GCVS elements for V775 Centauri were not correct, with the

Speaker	Title	Duration	Abstract
			stated period being double the period that I observed, and confirmed by finding a primary on 2011-09-04 and a much shallower secondary on 2011-09-07. In contrast, the period given in the GCVS for AA Crucis was half the actual period. In planning observing runs for the SPADES targets, we need to compare ephemeris data based on the GCVS, the Krakow Ephemeris calculator, D. Motl's Ephemerides programme, the O-C Gateway and ASAS phase plots (the latter two linked via the AAVSO VSX web site).
Margaret Streamer	The 2011 Eruption of T Pyxidis	30 mins	In early April, 2011, the recurrent nova, T Pyxidis, unexpectedly went into outburst (the prediction was for 2052). Southern hemisphere observers were well placed to participate in a thorough observational campaign. 23 Australian and New Zealand observers submitted results to the database of the American Association of Variable Star Observers. Observational techniques included visual, CCD and DSLR photometry. Rod Stubbings caught a short-duration pre-eruption rise, 13 days before the main eruption, followed by Linnolt (Hawaii) alerting the world to the start of the main eruption. This was confirmed by visual observers, Alan Plummer and Steve Kerr. Peter Nelson, Rolf Carstens and Margaret Streamer acquired time series photometry in multiple bands of the initial rise. The speed of the initial rise was 9 mag/day, representing a uniformly expanding shell. T Pyx finally peaked around magnitude 6.5. The decline to mag 11 initially showed numerous small flare-ups before following a steadier decline after about 140 days back to quiescence (mag ~15.5). The results and interpretations of this rare event will be presented, based on a paper by Brad Schaefer (Louisiana State University), with co-authors including Rod Stubbings, Alan Plummer, Steve Kerr, Peter Nelson, Tom Richards, Rolf Carstens and myself.
Tom Richards & Simon O'Toole	SPADES: progress, problems and prognosis	20 mins	The SPADES Project (Search for Planets Around Detached Eclipsing Stars) now has collected data on 46 target binaries. This paper will outline the goals and methods of the project, provide an overview of the data we have collected, and discuss the issues arising for the project from a review of that data.
David Moriarty	CCD Photometry Contributions to the SPADES Project: 2 CCD Imaging Issues	20 mins	For many target stars in the SPADES project that I observed in 2011, the derived magnitudes were close to the expected values, without applying transformation coefficients, whereas for some they were noticeably different. In the case of VX Normae, when a small change was made in the position of the stars on the CCD chip, derived magnitudes differed by about 0.4 mag. and the differences altered when different comparison stars were used, yet full calibrations were applied that should have minimised effects such as vignetting. This raises questions for discussion about imaging technique and whether transformations that take into account variations in seeing should be applied as part of the SPADES project.
SESSION 3			
Alan Plummer	Observing the Observers, through the Light Curve of eta Carinae	30 mins	A light curve carries more information than simple brightness. The historical light curve of eta Carinae gives insights into the European exploration of the southern seas, the establishing of the first southern

Speaker	Title	Duration	Abstract
			observatories at Saint Helena and the Cape of Good Hope and highlights the colonization of South Africa, Australia, and New Zealand. This story is told—briefly—by looking at the people who made these historically important estimates.
Tom Richards	Finding and Using your Transformation Coefficients	40 mins	Transformation Coefficients are the numbers that correct the colour photometry measures made on your idiosyncratic imaging system, aligning them with the “standard system” of star colours. Most variable star photometry requires colour filters and transformed colour data, but the business of acquiring your TCs seems difficult, and how you apply them to your observations obscure. This tutorial will try to explain why they matter, how you use them in practice, and how you find out what yours are.
Tom Richards	VSS discussion	20 mins	To wrap up the colloquium, an open discussion on what VSS is doing and where it should be going. My role is to listen, yours is to talk.

Bright Cepheids Report - *Stan Walker*



Visual measures continue to be made by Aline and John Homes, Bob Evans and Peter Williams with DSLR measures of some low amplitude and other important objects by Mark Blackford and Glen Schrader. Analysis of these has been delayed by lack of suitable master light curves but this has recently been rectified in large part by the publication on the International Database of the AAVSO of measures from the 1964 Tonantzintla Bulletin - thanks to the efforts of Doug Welch, Brian Skiff and Matthew Templeton in scanning that massive printed database.

Software Watch – *Phil Evans*

Muniwin. <http://sourceforge.net/projects/c-munipack/files/>

Version 1.2 of Muniwin by David Motl has now been released in stable form. There is very little difference in function between v1.1 and v1.2 but the newer version is platform independent and supports Canon and Nikon RAW image files from DSLR cameras.

When processing DSLR images, you are asked to select a transformation for RAW images to gray scale. This option is ignored if the source frames are already in gray scale.

- Grayscale - the program sums all four pixels in Bayer mask. The resulting image has half the resolution of the RAW image and its range is four times higher than the range of the original picture.
- Red / blue - the program takes only red and blue pixels respectively. The resulting image has half the resolution of the RAW image and its range is the same as the range of the original picture.
- Green - the program takes only two green pixels on diagonal, sums them and the result divides by two. The resulting image has half the resolution of the RAW image and its range is the same as the range of the original picture.

There are a number of minor changes in the way graphs are presented but on the whole the software still adheres to the standard set by the earlier version. The Help file now incorporates a ‘Theory of Operation’ section which is useful for those who want to understand how it functions and what the various parameters represent. And best of all it is still free.

Introduction

The region of M42, the Great Nebula of Orion, has been a source of fascination for at least 200 years, and attempts to map the stars belonging to it appear to date from the time of Sir John Herschel. Each new generation of astronomers seem drawn to it, only to have their work superseded as better technical means become available.

The most extensive Atlas and Catalogue in my possession is that produced by A.D. Andrews in 1981, while working at Armagh Observatory (Northern Ireland). David Andrews used copies of UK Schmidt plates, taken in UBVI, on one night at Siding Spring Observatory in 1974. By having these 4 plates scanned on the GALAXY machine at the Royal Greenwich Observatory he was able to measure precise positions for epoch 1974, equinox B1950.0, and magnitudes in the UBVI system for more than 16,000 stars. The area of sky ($21.4 \text{ sq } ^\circ$) covered by the plates is centred on M42, from

(B1950.0) RA 5h 23.0m to 5h 42.0m Dec. -3° to -7.5° or
(J 2000.0) 5 25.6 to 5 44.1 -3° to -7.5°

Andrews' Atlas was published in book form in 1981 as A Photometric Atlas of the Orion Nebula, giving charts based on ESO red plates and a complete catalogue of stars numbered up to 16777. Raw measurement data is given, as well as reduced data. The photometry is about 95% complete for B and V, and considerably less for U (probably $<50\%$). Magnitudes are very sparse for I band. The purpose of his Atlas was not simply to give a listing of stars, but an attempt to understand the astrophysical properties and dynamics of stars in the region of M42.

Utility of Andrews' Data

While his data has existed in hardcopy form for 30 years, it cannot be found online or at any data centre. The explanation is simple, though tragic. Through mishap or carelessness at a computer centre, the original computer files were overwritten shortly after the Atlas went into print. I obtained a copy of the Atlas in 1986, and the value of this large dataset for variable star work was obvious. The main problem was in accessing the data from the printed pages. Extracting small subsets of data can be a laborious and painstaking chore. By modern standards it is rather user-unfriendly, though I did make a determined effort in 1996 to prepare chart and sequence for the UG variable star, V1159 Ori. Andrews' catalogue cried out to be brought into the 21st century, to be computer-readable. In its current form it presents too many difficulties to be useful, especially as:

- ◆ stars are listed/numbered according to the scan strip in which they lie, NOT by Right Ascension
- ◆ the scans progress from east to west, the opposite direction to most star catalogues.

Moving from B1950 to J2000

Even when a star's position is known accurately and precisely for B1950.0, advancing its position to J2000.0 is more than just a matter of adding 50 years' worth of precession. The two epochs are defined differently, as follows:

- ◆ The instant of B1950.0 (Equinox and Mean Equator) is JD 2433282.4235
= 1950 January 0.9235 UT = 1949 December 31.9229 UT [Nutation neglected]
 - ◆ The instant of J2000.0 (Equinox and Mean Equator) is JD 2451545.0
= 2000 January 1, 1200 UT [Nutation neglected]
- B1950.0 is based on the Bessellian Year = 365.242198781d
J2000.0 is based on the Julian Year = 365.25d

So, in calculating the precession for 50 years, one has to be aware that "year" is defined in two ways. It's not my intention to go into all the technical details arising from the above. Anyone wishing to delve

further should consult the appropriate manuals, or two useful websites which are appended. Even if one makes the most precise adjustments for precession and proper motion, at least, there will be a slight mismatch between these two reference frames. The difference is small, but quantifiable.

For many years B1950.0 came to be synonymous in many situations with the SAO Catalogue. The SAO Catalogue is a compilation of star positions from many different sources, some less reliable than others, sometimes depending on declination zone. It is now obsolete as a primary source of astrometric positions. David Andrews relied on the SAO when carrying out the reductions on his Schmidt plates, and my own examination of the 53 SAO stars he used reveals the inherent noise in the SAO positions when compared with more modern catalogues such as Tycho-2, CMC14 and the like. In view of these facts I decided that, for the Andrews catalogue, the most time-effective way to adjust his positions to J2000.0, with reasonable accuracy while ensuring that the residuals are as small as possible on average, is the method I subsequently adopted:

- ◆ determine the mean RA/Dec offsets by direct comparison with J2000 positions from Tycho-2 and CMC14, for as many stars as practicable. Ultimately 2152 Tycho-2 stars were looked up, which is about 13% of the stars in Andrews' catalogue.

This method, in one swoop, compensates for the difference in the two reference frames (about 0.08s in RA) and other extraneous errors due to imprecisions in my spreadsheet formulae for precession. The actual offsets turned out to be ~0.15s in RA and ~5" in Dec, but varied according to position on the original Schmidt plate. It should be noted that my intention was NOT to create a new astrometric catalogue, but rather to create a dataset which can be read by GUIDE8®, and greatly facilitate access to Andrews' data by astronomers of the 21st century.

Keystroking the Data

Andrews' catalogue has stars numbered up to 16777, though it was obvious at a glance that some numbers had been skipped, and the final count would be somewhat lower than this. Because of the small print all data would have to be scrutinized under a magnifying glass. Some poorly printed characters were liable to be misread when working at speed - a "2" may be taken for "7" or "3" or whatever. In order to avoid burnout I initially limited myself to entering 150 stars (one half-page) of data per day/session. I figured that by maintaining this regular throughput (150 stars/day, or 1000/week) I would expect to finish the job by December 15, 2011. My plan of attack was as follows :

- ◆ enter selected items of data (star #, B1950 coordinates, BV magnitudes) into a spreadsheet set up for this purpose
- ◆ the spreadsheet, containing embedded formulae for precession, would generate preliminary updated positions for J2000.0
- ◆ the preliminary results would then be copied to another part of the spreadsheet, for inspection, and to allow easy sorting and separation of stars according to Right Ascension.
- ◆ all stars brighter than 13.0V (15-20 stars in every 150) would be selected, to permit comparison with J2000 positions taken from Tycho-2/CMC14/UCAC2.
- ◆ determine mean differences in position, of the order ~0.15s in RA, 5" in Dec., for these 15-20 stars, and apply corrections to the whole block, then save to a separate file.

Commencing on July 23, 2011 it took about 113 days to enter all of the Andrews' catalogue data into the spreadsheet, finishing on November 13. The processing of each block of stars was done on a day-by-day basis, and the results were saved in 20 separate files, according to RA (05h25m to 05h44m). It was found easier and safer to store data in lots of small files, rather than work with one big file, which would become unwieldy, and put heavy demands on memory and disk space. Having gone through the process, and assigned the stars to respective files based on RA, it was then a straightforward matter to turn each file into a plain text .DAT file, which could then be combined into a single file. My final list differs from the original in that my catalogue is arranged strictly according to RA, which was not the case with Andrews'. As a result, it will be noticed that high-numbered (5-digit) stars are now first, and low numbers come last.

Some Statistics

ANDREWS.DAT, my completed catalogue, contains the following objects:

- ◆ 16398 separate numbered objects, most of which are stars. Excludes 379 skipped numbers.
- ◆ 1 bright NGC galaxy, and 41 faint galaxies with PGC numbers
- ◆ 1 reflection nebula
- ◆ 2 stars which have proved to be non-existent, or not found on DSS plates.
- ◆ region of sky covered is RA (J2000) 5h25.6m to 5h44.1m, Dec. -3° to -7.5° .

Integration with GUIDE8

A primary objective was to enable a visual display of the entire Andrews catalogue using GUIDE8. Andrews.DAT, such as I have created, is not sufficient by itself. A Text Definition File (TDF) is required, to give GUIDE8 the instructions on how to plot the stars, on screen, and which items of data (coordinates, magnitudes etc) shall appear in the pop-up text boxes. For this purpose a TDF has been written, to meet this requirement. Of course, one can simply browse Andrews.DAT using a good text editor, but the experience may not be as satisfying. The whole package of files is contained in one .ZIP file, called ORION_NEB.ZIP.* When unzipped the files are :

ANDREWS.DAT The main data file of 16398 stars, 700kb

ANDREWS.TDF Text Definition File, for GUIDE8

README_2.TXT Readme file.

PARENAGO.DAT File of 2982 stars by P.P. Parenago, covering the dense central part of M42

PARENAGO.TDF Text Definition File, for Guide8

README_PAR.TXT Readme file

The Andrews' Atlas tends to avoid the region of most intense H II emission. Most stars in this region are in Parenago's 1954 catalogue, spanning (J2000) 5h 28m 55s - 5h 40m 55s RA, and -4.0° to -7.0° Dec.

[*Available on request from the author.]

Comparison with Other Photometry

The M42 region has three variables of large amplitude which have been on the AAVSO program for many years, namely S Ori (M), Y Ori (M) and V1159 Ori (UG). Precise APASS photometric sequences exist for all three stars, and this permits a comparison with Andrews' V mags, particularly at the faint end. The differences, APASS-ANDREWS (abbreviated AP-AN) are tabulated below.

Table 1. Comparison of V mags, AP-AN.

Mag. Range (V)	N	Mean	STD
11.0 - 13.0	19	-0.062	0.062
13.0 - 14.0	8	-0.093	0.050
14.0 - 15.0	9	-0.015	0.056
15.0 - 16.5	7	0.088	0.099

N = Number of stars in common.

STD = Standard Deviation

The quality of Andrews' photographic photometry appears reasonable down to 15.0V, but falls away noticeably below 15.0. The errors of APASS photometry are in the region of 0.020 or better, for V.

Concluding Remarks

This work is not intended as an astrometric catalogue, per se, but rather makes available Andrews' set of more than 16000 BV magnitudes down to 16.5V, around M42 (a region abounding with variables of various types), in a computer-readable format, especially with GUIDE8® in mind.

Acknowledgement

I thank Dr Andrews for rendering useful advice and pertinent information about his Atlas.

References

Andrews, A.D. 1981, "*A Photometric Atlas of the Orion Nebula*" Armagh Observatory, Armagh, Northern Ireland.

Websites

<http://www.stargazing.net/kepler/b1950.html>

Discussion of precession

http://en.wikipedia.org/wiki/Terrestrial_Time

Discussion of Terrestrial Time (TT)

<http://www.aavso.org/apass>

The AAVSO Photometric All-Sky Survey

DSLR Photometry

Atmospheric Extinction Correction – *Mark Blackford*

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Abstract

A simple procedure is described for correcting atmospheric extinction in long time series DSLR observations. Extinction coefficients are derived from the same images as the target and comparison star measurements. No additional images are required. The procedure is illustrated using observations of the E1 Region of photometric standard stars. It is then applied to observations of the eclipsing binary RS Sagittarii. One of the E1 Region standard stars, previously not suspected of variability, was observed to exhibit delta Scuti-like behaviour.

Introduction

The field of view (FOV) of an astronomical CCD camera imaging through a telescope is typically less than 30 arc minutes and airmass differences across the FOV are usually insignificant. In this situation there is generally no need to correct for atmospheric extinction when performing differential photometry. A DSLR camera with a conventional telephoto lens, however, has a much larger FOV which can lead to significant airmass differences across the frame. Differential extinction is most obvious in light curves derived from time series observations.

This article describes a procedure for determining single filter primary and secondary extinction coefficients from time series images and explains how to apply them to obtain above atmosphere instrumental magnitudes. Images of a standard star field, whilst not necessary for extinction coefficient determination, allows measurement of transformation coefficients from the same data. The procedure is illustrated by applying it to measurements of a primary eclipse of the EA/SD eclipsing binary RS Sagittarii. One standard star was observed to be variable, possibly a delta Scuti type, and this will be discussed at the end of this article.

Experimental Data

Images were recorded using a Canon 450D DSLR plus Nikkor 180mm lens (FOV 4.7° x 7°) and were calibrated and measured using aperture photometry in the usual manner. The Magnitude Measurement Tool in AIP4WIN V2.4.2 was used to measure star ADU intensities. This is the background subtracted intensity of each star in analogue-to-digital units (Berry and Burnell, 2005). The software also calculates airmass for EACH star (target, comparisons and check) at the time of each image in the series. It is not sufficient to calculate an average airmass for each image.

The Cousins E1 Region was imaged at 2 minute intervals from just prior to culmination until approximately 25 degrees elevation. This corresponded to airmass ranging from approximately 1 to 2.3 atmospheres. Lower elevations were precluded by the skyline of the observatory. The FOV included twenty standard stars between magnitudes V 6.5 and V 8.5.

Two stars, E143 (HD 8391) and E167 (HD 9542), were not used to determine extinction coefficients because their data points deviated significantly from linear trends defined by the other 18 stars. The reasons for these anomalies have been investigated. There are no stars close to either E143 or E167 bright enough to affect measurements. In all three colour filters E143 was more than 2.5 standard deviations above the trend lines shown in Figure 3 below. This star is listed in the New Catalogue of Suspected Variable Stars (NSV 488), however the AAVSO Variable Star Index has it tagged as non-variable. The amplitude of variability determined from Hipparcos measurements is 0.0098 magnitude in V (Koen and Eyer, 2002) which is unlikely to be significant in the context of this study. If variability was the reason for the discrepancy it would require a steady brightening over the observation period of 0.05, 0.03 and 0.03 magnitude in blue, green and red, respectively. These are well in excess of the Hipparcos V amplitude. As yet there is no clear explanation for the anomalous results for E143. Green and red filter data for E167 were in close agreement with trend lines in Figure 3, however the blue filter data was more than 2 standard deviations above the trend line. Of the twenty standard stars E167 was the faintest in B, therefore this anomalous data point may simply be due to poorer quality data.

The RS Sagittarii data were collected with the same equipment and measurement routine.

Extinction

The observed magnitude of a star is increased (ie brightness decreased) by atmospheric extinction as described by the following equation (Sarty, 2004):

$$a = a_0 + (k'_a + k''_a c)X \quad (1)$$

Where:

- a = raw instrumental magnitude in colour filter b, g, or r (Bayer filters)
- a_0 = above atmosphere instrumental magnitude
- k'_a = primary extinction coefficient
- k''_a = secondary extinction coefficient
- c = instrumental colour index of the star
- X = airmass in atmospheres

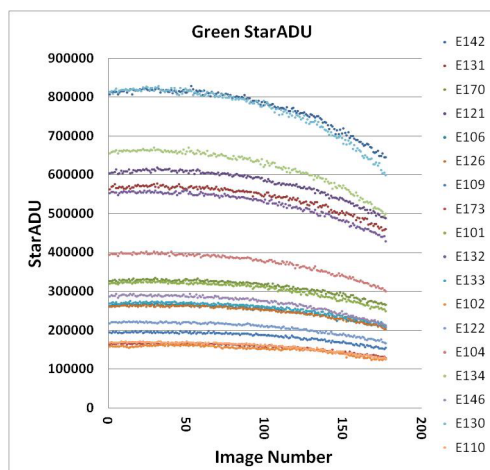


Figure 1. Green filter Star ADU intensity as a function of time.

Figure 1 plots measured green filter Star ADU intensity as a function of image number in the time series. Observations started just before culmination and continued for about 6 hours. Star ADU intensity initially increases before steadily decreasing due to extinction as airmass increases (more atmosphere = more scattered light).

Primary and secondary extinction are easier to visualise when Star ADU intensity is converted to raw instrumental magnitude, normalised then plotted against airmass, as shown in Figure 2. A three point rolling average was applied to make it easier to see light curves of individual stars.

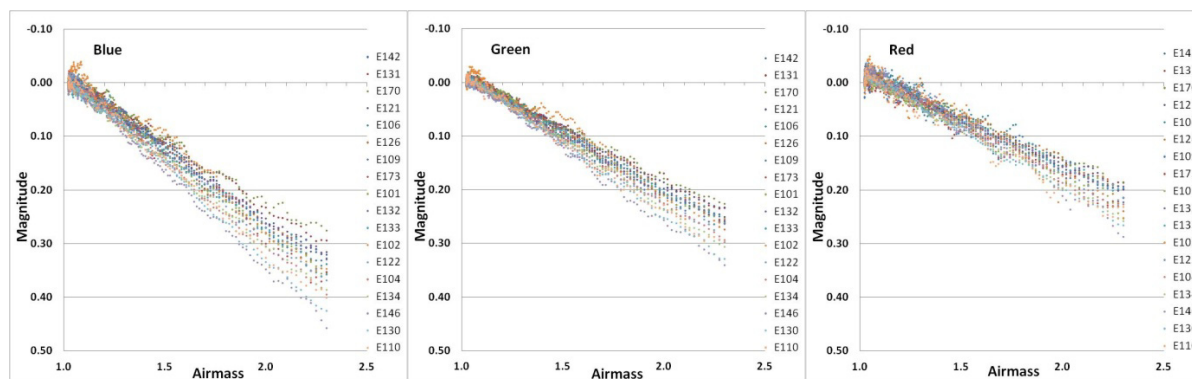


Figure 2. Normalised extinction as a function of airmass for the three colour filters.

For a normal atmosphere, where Rayleigh scattering from gas molecules dominates, primary extinction is greater in the blue part of the spectrum. This is evident by steeper light curves for the blue filter compared with green and red filters. Light curves fan out as airmass increases due to secondary extinction which also is greater in the blue part of the spectrum. This can be seen by the larger spread of light curves in the blue filter.

Primary extinction varies from night to night, even throughout a single night, as atmospheric conditions change (Henden and Kaitchuck, 1990). Figure 6.7 in Budding and Demircan, 2007, illustrates how measured primary extinction varied with wavelength at several observatories. Secondary extinction coefficients, however, should not vary much throughout a season unless some aspect of the imaging system changes (filters, lenses, sensor, etc).

In situations where airmass differs significantly between comparison and target stars, eg all sky photometry and wide angle DSLR differential photometry, the effects of both primary and secondary extinction need to be accounted for in order to achieve accurate photometric measurements. This is done by first determining extinction coefficients then applying equation 1 to correct instrumental magnitudes, as discussed below.

Determining Extinction Coefficients

Equation 1 is of the general linear form:

$$Y = A + BX \quad (2)$$

Therefore a plot of instrumental magnitude versus airmass has Y axis intercept equal to the above atmosphere instrumental magnitude, a_0 , and slope equal to $(k'_a + k''_a c)$. When colour index $c = 0$ the slope equals the primary extinction coefficient. Table 1 lists slope and intercept for each star in b, g and r colour filters and the measured above atmosphere b-g and g-r instrumental colour indices. The LINEST function in Excel was used to determine these coefficients, including error estimates in brackets.

Coefficients listed in Table 1 are specific to each star and should be used to correct for atmospheric extinction of that star only, provided it is not a variable. However, the $(k'_a + k''_a c)$ of one star could be applied to another star if both have very similar colour indices.

Star	$k'_b + k''_b c$	b_0	$k'_g + k''_g c$	g_0	$k'_r + k''_r c$	r_0	$b_0 - g_0$	$g_0 - r_0$
E142	0.274(2)	-14.805(3)	0.220(2)	-15.008(2)	0.174(2)	-13.965(3)	0.203(3)	-1.043(3)
E131	0.269(2)	-14.058(3)	0.214(2)	-14.614(3)	0.174(2)	-13.880(3)	0.556(4)	-0.734(4)
E170	0.270(3)	-13.513(4)	0.218(2)	-14.024(3)	0.188(3)	-13.266(4)	0.512(5)	-0.759(5)
E121	0.274(2)	-14.250(3)	0.213(1)	-14.687(2)	0.177(2)	-13.879(2)	0.437(3)	-0.808(3)
E106	0.282(2)	-13.595(3)	0.220(2)	-13.793(3)	0.177(4)	-12.789(5)	0.198(4)	-1.005(6)
E126	0.283(3)	-13.388(4)	0.216(2)	-13.776(3)	0.170(3)	-12.940(5)	0.387(5)	-0.835(5)
E109	0.278(3)	-13.197(4)	0.219(2)	-13.455(3)	0.179(4)	-12.499(6)	0.258(5)	-0.956(7)
E173	0.281(4)	-12.793(5)	0.209(2)	-13.270(3)	0.177(4)	-12.515(5)	0.477(6)	-0.755(6)
E101	0.290(2)	-13.975(3)	0.225(2)	-14.011(3)	0.187(3)	-12.863(5)	0.036(4)	-1.147(5)
E132	0.268(2)	-13.865(3)	0.213(2)	-14.585(2)	0.177(2)	-14.008(3)	0.720(4)	-0.576(3)
E133	0.269(4)	-13.101(5)	0.205(2)	-13.800(2)	0.167(3)	-13.228(4)	0.699(6)	-0.573(4)
E102	0.283(4)	-13.149(6)	0.217(4)	-13.246(5)	0.195(6)	-12.187(8)	0.098(8)	-1.059(10)
E122	0.279(3)	-13.120(5)	0.217(2)	-13.590(3)	0.174(4)	-12.818(5)	0.471(5)	-0.772(6)
E104	0.289(2)	-14.058(3)	0.220(2)	-14.229(2)	0.180(3)	-13.205(4)	0.170(4)	-1.023(4)
E134	0.261(2)	-14.051(3)	0.210(1)	-14.771(2)	0.174(2)	-14.196(2)	0.720(3)	-0.576(3)
E146	0.290(2)	-13.916(3)	0.223(2)	-13.889(2)	0.181(3)	-12.678(5)	-0.028(4)	-1.211(5)
E130	0.273(2)	-14.428(2)	0.212(1)	-15.004(2)	0.173(1)	-14.308(2)	0.576(3)	-0.696(3)
E110	0.280(3)	-13.068(4)	0.219(2)	-13.303(3)	0.182(4)	-12.345(6)	0.235(5)	-0.958(7)

Table 1. Measured extinction parameters and above atmosphere instrumental magnitudes and colour indices of the 18 standard stars.

Calculated ($k'_a + k''_a c$) values will be wrong if a star varies significantly over the time of observations. In this situation the k'_a and k''_a terms need to be determined separately (using data from non-variable stars) before we can correct for atmospheric extinction of a variable. Using the data in Table 1 we can plot ($k'_a + k''_a c$) versus ($b_0 - g_0$), Figure 3. The slopes of lines of best fit are equal to the secondary extinction coefficients and Y axis intercepts, ie ($b_0 - g_0$) = 0, are equal to the primary extinction coefficients. A similar plot could be constructed using the ($g_0 - r_0$) colour index.

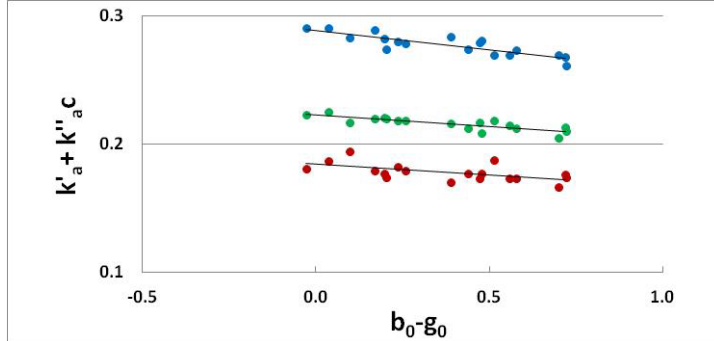


Figure 3. Extinction as a function of instrumental ($b_0 - g_0$) colour index.

The LINEST function in Excel was used to determine the coefficients listed in Table 2, including error estimates in brackets. These coefficients should be used to correct for atmospheric extinction of variable stars. Alternatively, the ($k'_a + k''_a c$) value of a star with similar colour index to the variable could be used to achieve very good extinction correction.

Primary Extinction Coefficient		Secondary Extinction Coefficient	
k'_b	0.289(2)	k''_b	-0.030(4)
k'_g	0.223(1)	k''_g	-0.018(3)
k'_r	0.184(3)	k''_r	-0.017(6)

Table 2. Primary and secondary extinction coefficients.

It is important to remember that coefficients in Tables 1 and 2 are correct for the night the images for this study were collected. They may not be appropriate on other nights if atmospheric conditions are significantly different. Repeated measurements throughout the year would allow average coefficients to be

determined. These could be used to achieve reasonable extinction correction on nights when coefficients were not specifically determined.

Applying Extinction Corrections

Rearranging Equation 1:

$$a_0 = a - (k'_a + k''_a c)X \quad (3)$$

allows us to calculate the above atmosphere (airmass $X = 0$) instrumental magnitudes from measured raw instrumental magnitudes and airmass. For non-variable stars coefficients in Table 1 are substituted into equation 3. For variables the coefficients in Table 2 should be used. Alternatively, Table 1 coefficients of a star with similar colour index could be used. Figure 4 shows normalised extinction corrected instrumental light curves as a function of airmass plotted at the same vertical scale as the uncorrected light curves in Figure 2.

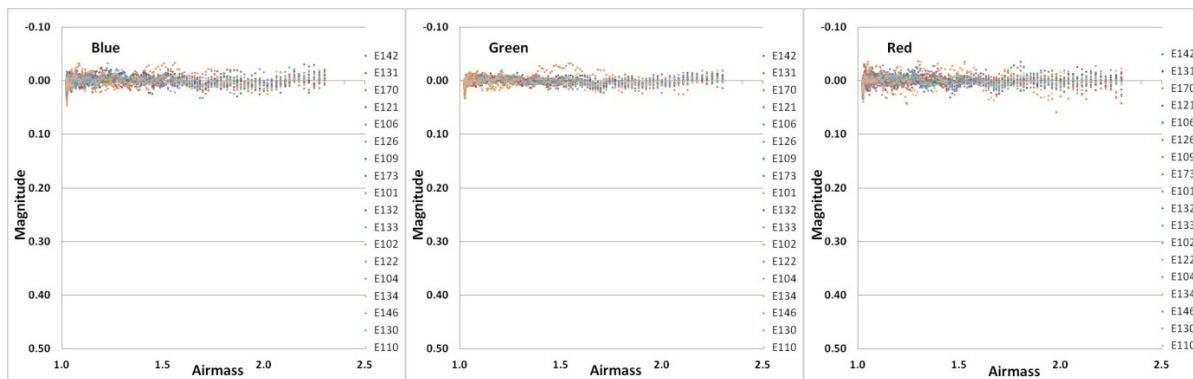


Figure 4. Normalised extinction corrected instrumental magnitudes as a function of airmass for the three colour filters plotted at the same scale as Figure 2.

Comparison of Figures 2 and 4 confirms that correction of both primary and secondary atmospheric extinction has been achieved.

Application to Eclipsing Binary Time Series Data

The procedure for determining and applying extinction coefficients described above, whilst accurate, is not practical when imaging multiple fields throughout a night because of the time required. However it is ideal for long time series observations such as the primary eclipse of RS Sagittarii discussed below.

Three comparison stars (HD165793, HD167846 and HD 167230) and one check star (HD 169398) were chosen because their B-V and V-R colour indices are similar to RS Sagittarii out of eclipse. Normalised plots of extinction as a function of airmass are shown in Figure 5. The light curve of RS Sagittarii is skewed because airmass changes non-linearly with time.

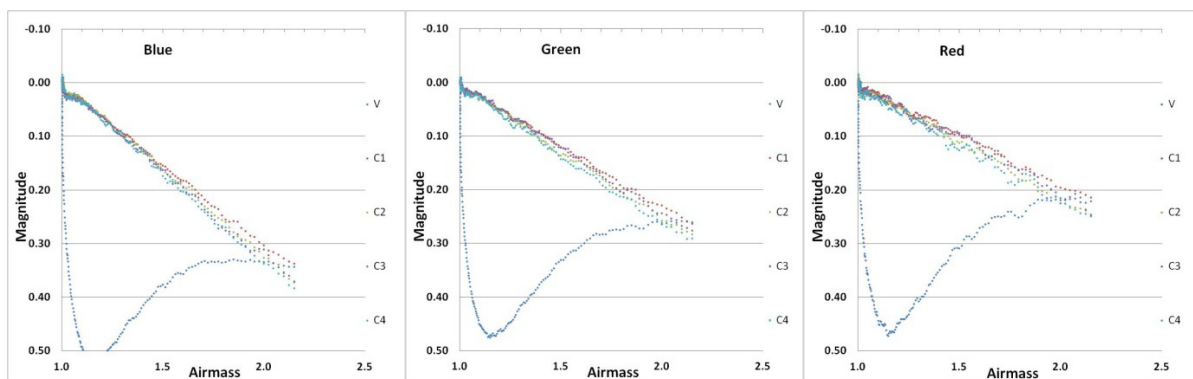


Figure 5. Normalised extinction of RS Sagittarii, check and comparison stars as a function of airmass for the three colour filters.

Instrumental magnitudes of the check and comparison stars were corrected by applying the appropriate ($k'_a + k''_a c$) value from Table 3. Instrumental magnitudes of RS Sagittarii were corrected using the average ($k'_a + k''_a c$) values. This is an acceptable approximation because all the stars have similar B-V and V-R colour indices. Normalised plots of extinction corrected instrumental magnitudes as a function of airmass are shown in Figure 6.

Star	$k'_b + k''_b c$	$k'_g + k''_g c$	$k'_r + k''_r c$
HD169398	0.322(2)	0.248(1)	0.206(2)
HD165793	0.310(2)	0.242(1)	0.204(2)
HD167846	0.339(3)	0.259(1)	0.212(3)
HD167230	0.317(2)	0.247(2)	0.205(3)
Average	0.322(13)	0.249(7)	0.207(3)

Table 3. Measured extinction parameters.

Comparison of coefficients in Tables 1 and 3 shows that atmospheric extinction was slightly greater on the night RS Sagittarii data was collected compared to the night the E1 Region was imaged.

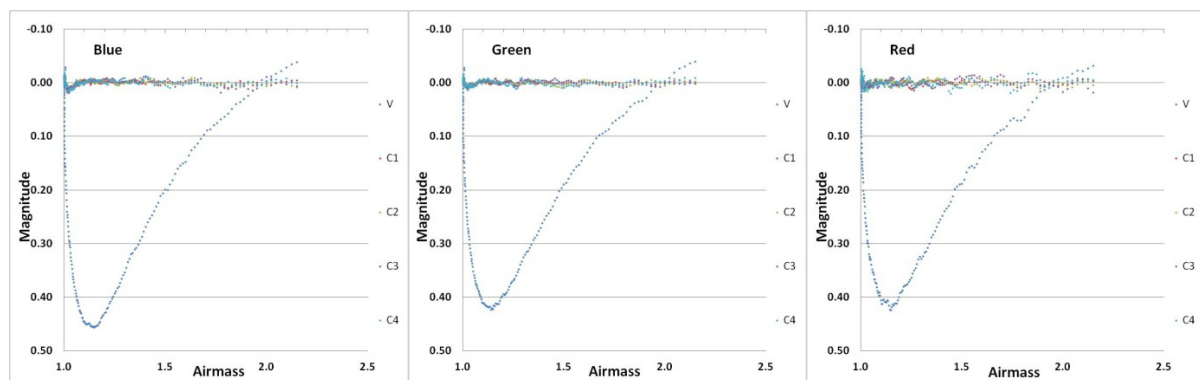


Figure 6. Normalised extinction corrected instrumental magnitudes as a function of airmass for the three colour filters plotted at the same scale as Figure 5.

Figure 7 shows transformed light curves of RS Sagittarii and the check star before (left) and after (right) correcting for atmospheric extinction. For clarity the check star magnitudes were adjusted by -0.196, -0.371 and -0.241 in B, V and R, respectively.

The improvement is obvious in the check star light curves where maximum correction was 0.035, 0.026 and 0.020 magnitude in B, V and R, respectively. RS Sagittarii and the three comparison stars are quite close together so correction for differential extinction amounted to 0.002 magnitude or less.

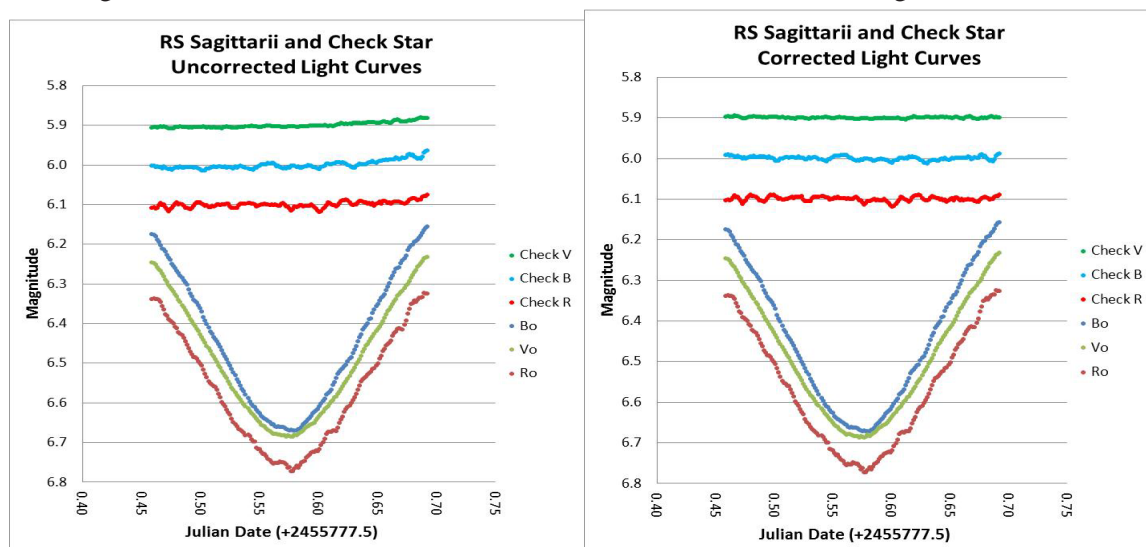


Figure 7. Transformed light curves in V, B and R as a function of Julian Date for RS Sagittarii and check star HD169398. Left graph shows data uncorrected for atmospheric extinction. Right graph shows corrected data.

Standard Star E102

E Region standard stars (Menziés et al, 1989) provide fundamental standards for UBVRI photometry in the southern hemisphere. They have been carefully measured many times and are considered to be well characterised. A number of known or suspected variables are included, and noted as such, in the catalogue. However star E102 (HD 8382) is not one of these, so it was surprising to find in this study a small but definite brightness variation. This can be seen in Figure 4 where the E102 instrumental light curves rise above the others at airmass of ~ 1.5 atmospheres.

Extinction corrected instrumental magnitudes of E102 were transformed to standard BVR magnitudes (Blackford and Schrader, 2011) and plotted in Figure 8. Star E146 was chosen as the check star. Both E102 and E146 were reduced against an ensemble of the other 16 stars. Transformation coefficients were derived from the E1 Region standard stars measured in this study. The coefficients and estimated errors are:

$$\begin{aligned} T_v &= 0.112(9) \\ T_{bv} &= 2.122(32) \\ T_{vr} &= 1.316(17) \end{aligned}$$

The large transformation coefficients magnify scatter in the light curves so a rolling 5 point average was applied. To make it easier to plot at a suitable vertical scale 0.060, 0.228 and 0.222 was added to the check star V, B and R magnitudes, respectively.

During the observation session the amplitude of variation of E102 was approximately 0.08 magnitude in B and 0.06 in V, with a period of ~ 0.13 days. The R light curves are quite noisy making it difficult to estimate the amplitude.

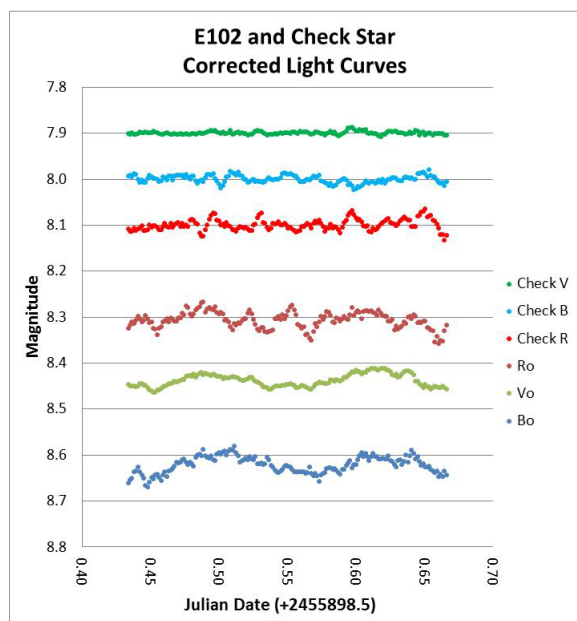


Figure 8. Transformed light curves as a function of Julian Date for star E102 and check star E146.

The SIMBAD database (<http://simbad.u-strasbg.fr/simbad/>) lists the spectral type of E102 as A3III/IV and identifies it as a double star (CCDM J01222-4613AB). The Catalogue of Components of Double & Multiple stars (CCDM, available through SIMBAD) lists the separation as 3.5 arcsec with the A component at 8.3 photographic V magnitude. The B component is listed at 13.5 photographic V magnitude which is too faint to affect the measurements. No other stars were present within the measurement aperture. E102 may be a delta Scuti type (DSCT) variable which is defined in the General Catalogue of Variable Stars (Samus, et. al., 2011) as:

Variables of the Delta Scuti type. These are pulsating variables of spectral types A0-F5 III-V displaying light amplitudes from 0.003 to 0.9 mag in V (usually several hundredths of a magnitude) and periods from

0.01 to 0.2 days. The shapes of the light curves, periods, and amplitudes usually vary greatly. Radial as well as nonradial pulsations are observed. The variability of some members of this type appears sporadically and sometimes completely ceases, this being a consequence of strong amplitude modulation with the lower value of the amplitude not exceeding 0.001 mag in some cases. The maximum of the surface layer expansion does not lag behind the maximum light for more than 0.1 periods. DSCT stars are representatives of the galactic disk (flat component) and are phenomenologically close to the SX Phe variables.

The spectral type, measured magnitude range and period of E102 are consistent with delta Scuti type variability. Possible sporadic variability could explain why it has remained unknown until now.

Conclusions

The simple procedure described above effectively removes extinction effects from time series datasets using coefficients derived from the same data. With accurate extinction correction it becomes feasible to observe at higher airmass thereby allowing extended coverage of rapidly varying targets such as eclipsing binary stars.

The technique is not suitable for nights where atmospheric extinction varies significantly throughout the observing session due to cirrus, fog, smoke, passing weather fronts, etc. Measurements over multiple nights would allow average extinction coefficients and error estimates to be determined. These could be applicable to non-time series observations. Over time, seasonal variations should eventually become evident.

Analysis of data recorded from the Cousins E1 standard star region suggests that star E102 (HD 8382) is actually a variable, possibly of the delta Scuti type. Further study is required to confirm these findings.

Acknowledgments

I am indebted to Stan Walker and Ed Budding for their help and encouragement during the preparation of this article

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Turning up Results in SPADES - *Tom Richards (Joint project leader)*

tom@prettyhill.org

A surprise hand

For an observer, the aim of this project is to catch eclipses of certain detached eclipsing binaries to the best possible accuracy. For the analyst, the first aim is to measure times of minimum in those observations. But to Search for Planets Around Detached Eclipsing Stars we need to find a lengthy run of ToMs from whose oscillations around predicted times the presence of a third body - maybe a planet - can be inferred. For more on this science case, and observation methods, please visit <http://www.variablestarssouth.org/index.php/research-projects/spades>.

To date, observers Bill Allen, Steve Kerr, David Moriarty, Yenal Ogmen and Margaret Streamer have provided 71 time-series observation sets on 45 target binaries. These “obsets” have been analysed to find ToMs in them and their deviations from prediction (O-C or Observed – Calculated). Analysts are Mark Blackford, Roland Idaczyk, Ranald McIntosh, David Moriarty, Tom Richards and Margaret Streamer. No observer analyses their own data. You can find the observational data files, ephemerides, and observation summaries stored by target name under <http://www.variablestarssouth.org/index.php/research-projects/spades/spades-files>. In addition, there’s a table summarising all O-C data so far at the end of this article. To date, all we have done is find ToMs in the obsets and compare them with predictions. But even at that elementary stage the fun, and the headaches, start.

Some targets and the headaches they cause

Have a look at V775 Cen in the table. This binary got off to a good start – no headache. In the O-C column you’ll see three good measures of ToMs that agree nicely with Shawn Dvorak’s light elements, which he derived from a study of ASAS3 data. (In the table, the C Source column shows the source of the light elements used to construct the ephemeris that best fits observed minima.) More eclipse observations of this binary and we can start to build up a good O-C pattern.

But now look at AA Cru in the table. A bit more complicated. The two obsets with minima have O-Cs that agree within their limits of error. The first obset had a very noisy minimum, and the second’s minimum was right at the end of the run – see Figure 1. Such difficulties are not conducive to good measurement, but what we got was good enough to confirm that eclipses are running 33 minutes early on the Krakow ephemeris. Observers need to take this into account when planning an observation run to capture the entire eclipse. That discrepancy also suggests there have been changes in period, but we can’t know until we find more times of minimum in the literature, and observe more ourselves.

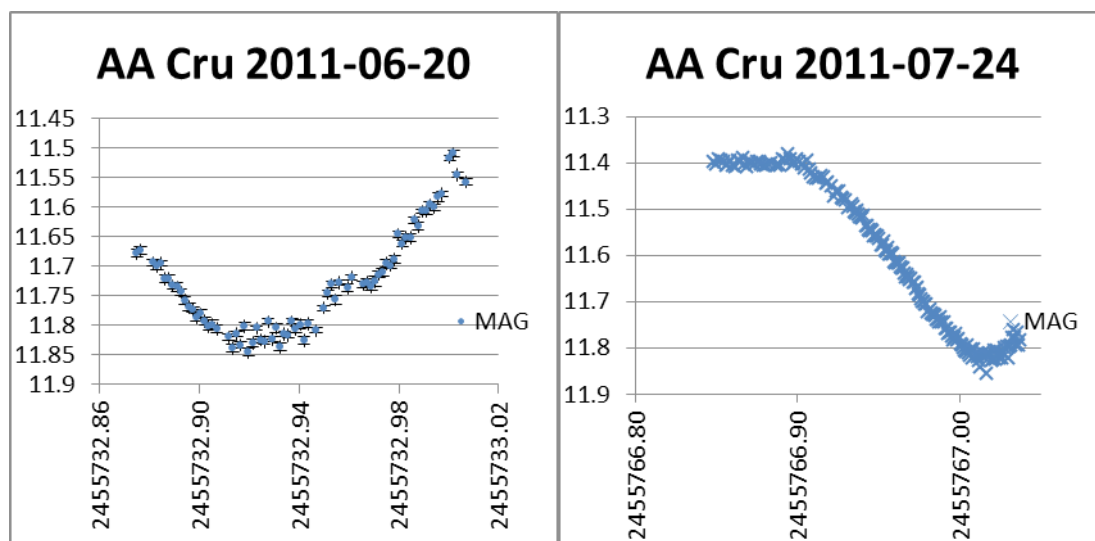


Figure 1. Primary minima of AA Cru by David Moriarty. Both plots show untransformed V-band magnitudes against HJD.

BE Cru shows how different the published light elements can be. The first obset in the table was from HJD ...5727.877 to ...5728.054. The GCVS predicted a minimum right in the middle, at ...5727.983. But the plot seems flat, out of eclipse, as in Figure 2. Or is it a minimum? The period is 2.2 d, and the observations cover a bit under 0.2 d. But that would make it an unlikely long minimum.

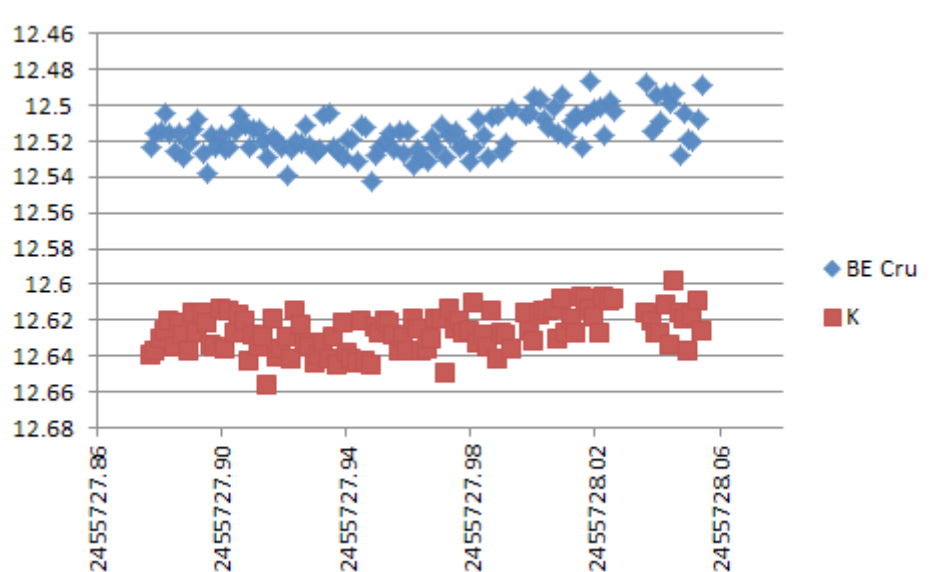


Figure 2. David Moriarty's observations of BE Cru on 2011-06-01. Out of eclipse, or flat minimum?

Well, try another ephemeris. The BRNO O-C Gateway records the only other light elements I can find.

$$\text{MinI} = \text{HJD } 2453401.054 + 2.220947 \text{ E}$$

Outcome? BRNO predicts no minimum anywhere near this obset - good. However for David's other two obsets, it predicts a secondary minimum just after David's second run finished, and a primary minimum just before his third observation run started. And indeed, David recorded a descent and ascent respectively, as in Figure 3.

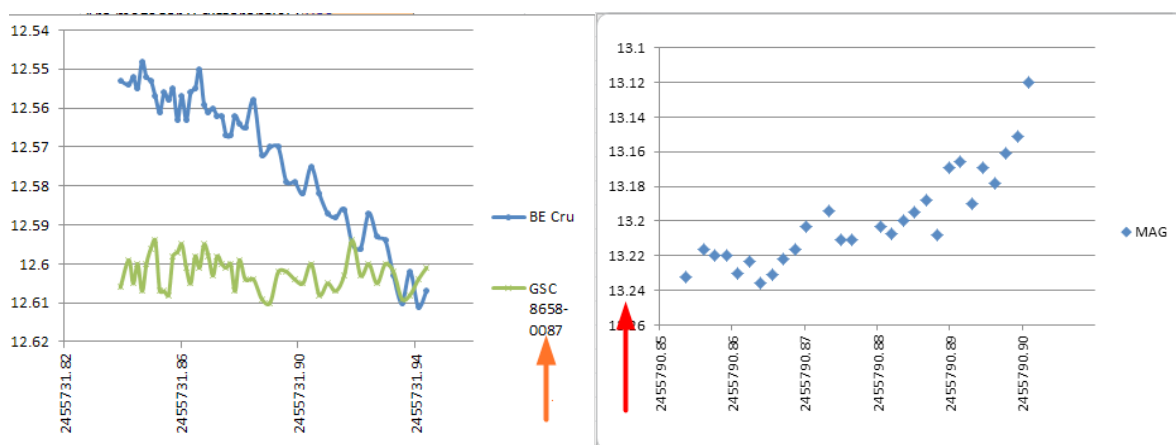


Figure 3. David Moriarty's observations just before a predicted secondary minimum (left) and just after a predicted primary minimum (right). Note the different magnitude scales. The red arrows show the times of the predicted minima.

This suggests that observers should use the BRNO elements for planning observations of this binary.

Move on to W Gru. The predictions here were from SuperWASP, which are about as accurate as you can get: in this case the uncertainty in C is 0.00007 d or 6 seconds. The minimum could be measured quite well in PERANSO (www.peranso.com) with an uncertainty of 0.0001 d. Yet O-C = -0.034 d = -49 minutes!

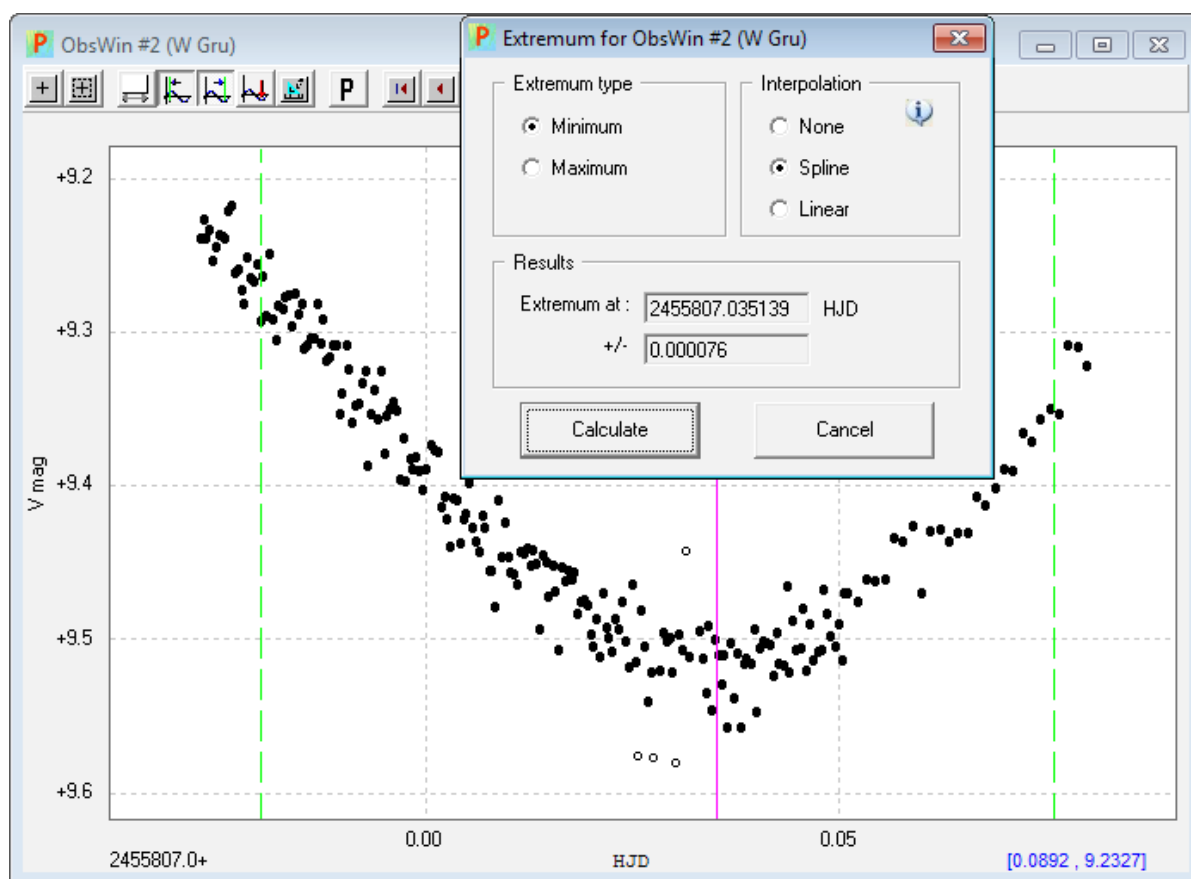


Figure 2. Steve Kerr's eclipse data for W Gru.

What's happening? Steve's computer clock is not going to be nearly an hour wrong. The SuperWASP epoch is very recent, 2006-09-14. However it takes no account of possible period variation, and indeed Cerruti (1987) surveyed data for the previous century and derived quadratic light elements of:

$$\text{MinI} = \text{HJD } 2430132.153 + 2.9685061 \text{ E} + 7.52 \times 10^{-9} \text{ E}^2$$

This amounts to a linear change in period of 0.083 s yr^{-1} , which comes nowhere near accounting for the observed O-C. So all we can say right now is that a mystery remains about this binary, which won't be resolved until we get more good eclipse observations.

That should be enough to give you a taste of the issues facing SPADES at this stage. Just about every target observed so far has problems like those above. In addition, if you keep browsing through the table you'll find several O-C entries marked "no C", where a minimum was observed but none predicted to occur. These need intense observation to try to find more eclipses and derive light elements. Then we can try working back through the literature to explain the anomalies.

More common are "no O" entries, meaning that observations carried out at the time of a predicted eclipse showed no minimum. But, particularly where it's a GCVS ephemeris, we can put the anomaly down to poor light elements from a time long ago. Some of our targets have just the GCVS light elements dating from time of discovery in the 1930s or thereabouts, and no other data. BX Mus is an example – discovered in 1927 then forgotten. Some also have light elements derived from ASAS3 data in (Dvorak 2004), but since a given star got recorded by the ASAS camera about every third day, epochs are not reliable. Otherwise an online search might be lucky to find one other ToM. So in these cases the observer can only toss a coin to decide which ephemeris to use, or none at all, and just hope to find eclipses.

What's the poor observer to do?

The conclusion from this situation is clear. Most southern eclipsers, even bright ones, have almost no data on them, and we need to provide it if SPADES is going to find planets. But our first job is to find eclipses, and on this score the available ephemerides can be quite misleading. So when an eclipse is captured, we need to find the ephemeris that gets closest – GCVS, Krakow, what? – and use that to guide observation planning.

So how is an observer to decide what targets to observe tonight, when ephemerides can be so misleading? If it's already under observation in SPADES, have a look at the files on it at <http://www.variablestarssouth.org/index.php/research-projects/spades/spades-files>. By looking at the Observations Summary file and Ephemeris file, it may be clear which ephemeris to use – and you can adjust the ephemeris file to give you the predictions you need. But as a rule, prefer any source of light elements over the GCVS.

Incidentally if you find more light elements than the ones used in a particular ephemeris file, add them in and send the updated file to me and I'll put it on the website.

It would also be very valuable if every observer and analyst of a particular target added some comments to the online forum on that target. Go to <http://www.variablestarssouth.org/index.php/forum/16-spades>. In particular, mention ephemeris problems, best ephemeris, and any problems or advice for other observers and analysts. If the target binary doesn't have a forum yet, email me and I'll create it. That will help us all to capture good eclipses.

Then we can proceed to derive good light elements, and thus the ultimate goal of O-C diagrams.

O-C Table

O-C column:

No O Min predicted but none observed

No C Min observed but none predicted

Nil No min predicted or observed

C Source column:

Entries here are the best source found for predicting observed minima.

B BRNO O-C Gateway <http://var.astro.cz/ocgate/>

D (Dvorak 2004)

G GCVS <http://www.sai.msu.su/gcvs/cgi-bin/search.htm>

K Krakow, <http://www.as.up.krakow.pl/ephem/>

S SuperWASP <http://www.superwasp.org/index.html>

Target	Observer	O-C [days]	C source	Target	Observer	O-C [days]	C source
AS Car	DM	nil	G	V384 Nor	DM	no O	G
DO Car	DM	nil	G	VX Nor	DM	nil, no O, no O, no O	D
V762 Cen	DM	nil	G	V456 Oph	YO	nil, no O	K
V775 Cen	DM	0.002, 0.003, 0.000, nil	D	CT Phe	WA	-0.02	S
AR CMa	MS	-0.03	B	RV Pic	DM	0.0456	G
TU CMa	MS	-0.001	K	AH Pup	MS	no O	D
V471 CrA	MS	no O	G	CU Pup	MS	no O	B
AA Cru	DM	nil, -0.024, nil, -0.022	K	CE Scl	MS, SK	no O, 0.002	S
AF Cru	DM	0.226, 0.225	G	V457 Sco	DM	no C	G
BE Cru	DM	nil, nil, nil	B	V491 Sco	DM, MS	no O, no O	G
SZ Cru	DM	nil, nil, 0.004, 0.004, 0.004	D	V569 Sco	MS	0.002	Z
CW Eri	SK	-0.018	G	V634 Sco	DM	0.040	G
AT For	MS	nil	S	V638 Sco	DM	no O	G
RU Gru	MS	0.002, 0.004	S	V640 Sco	DM	0.000	G
W Gru	SK	-0.039	S	V356 Sct	MS	-0.022	D
LT Her	YO	nil, nil, nil, -0.001, 0.004	D	V526 Sgr	MS	no O	S
TT Hor	MS	nil	S	V849 Sgr	MS	-0.019	S
FV Lup	DM	nil, 0.00, 0.00	K	V2351 Sgr	MS	-0.002	G
FZ Lup	SK	nil	D	IZ Tel	DM	0.046	G
RZ Mic	MS	-0.024, 0.009	S	LU Tel	DM	0.018	G
AS Mon	MS	0.029	B	EQ TrA	SK	nil	G
BX Mus	DM	0.100	G	AO Vel	MS	-0.036	K
GM Nor	DM	no O	D				

References

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Dvorak, S. 2004. IBVS 5542.

The region around eta Carinae is rich in stars which vary in brightness for a variety of reasons. Eta itself has, since 1980, become naked eye at a distance of approximately 7000 light years and others are almost as bright. It is a young star forming region along the spiral arm and contains a number of clusters - not unexpected if we're looking along the arm. Many of the stars are heavily reddened - the massive eclipsing binary system of QZ Carinae with three O type stars and an early B star has a B-V colour of +0.14 and U-B of -0.80 indicating reddening of ~ 0.3 and ~ 0.5 in B-V and U-B respectively. Quite clearly the V magnitude would be much brighter without the dust and gas clouds between us and the region which obscure about 90% of the stars' light.

3 7
 4 8
 5 9
 6 10
 0h44m22.9s J2000.0
 59°59'35" Car
 Level 6: 5 degrees

There are 22 Cepheids brighter than $V = 10.0$ and some of these are on the Bright Cepheid project list. With the uncertainties now surrounding the ASAS project some of the ones between $V = 8.5$ and 10.0

could be added to the list. Longer exposures will be required. Not shown on this chart is II Carinae, described in the GCVS as a Cepheid with a very long period of 64.24 days - but at ~12.0 at maximum it's a bit faint. The colours don't look all that Cepheid-like and the light curve is unusual - maybe, like V382 below, it's misclassified.

We've recently been requested by David Turner of St Mary's University, Halifax in Canada, to observe a rather neglected class - the SRc and Lc stars. There are 13 of these in the same field, ranging from V337 Carinae at 3.36 - 3.44 to CL Carinae at 9.7 - 12.2, but probably brighter as these are photographic magnitudes. Guide 8 gives $V = 8.61$ for CL but this may not be at maximum. Of the 6 Lc stars none has a quoted period and the SRc periods may well be incorrect.

Whilst measuring eta Carinae itself from Auckland, for a while we measured BO and RT Carinae in UB_v. The light curves are shown in Figure 2a and 2b. Regretfully this might be classed as random data as the measures are not dense enough to reveal the true light curve shape.

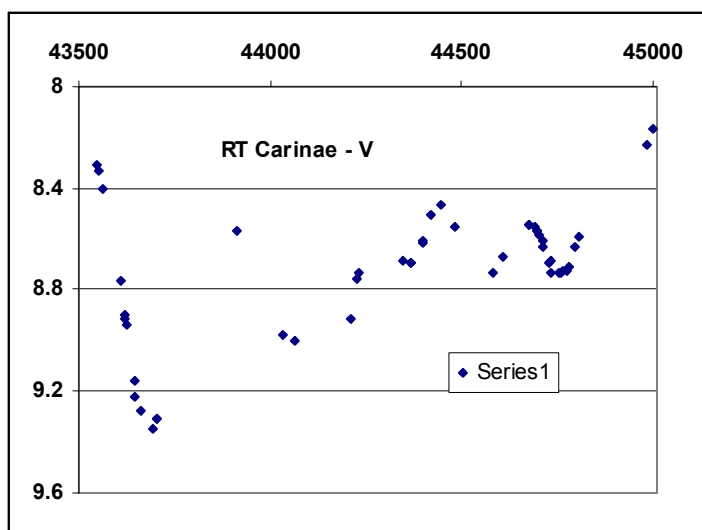


Figure 2a. RT Carinae has a B-V colour of ~2.3 and a spectral class of M2Iao.

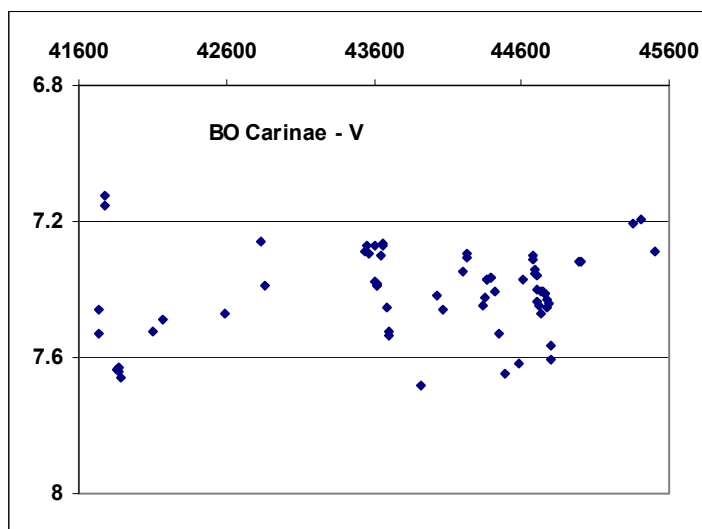


Figure 2b. BO Carinae has a B-V colour of ~1.8 and a spectral class of M4Ib.

There are 24 eclipsing binaries in the region and one ellipsoidal variable. The period of the latter is not quoted but 6 EBs have periods in excess of 10 days and 6 have no periods given. Of the 18 epochs quoted 12 are prior to JD 2438000. The brightest of these is QZ Car at $V = 6.22$. V429, a system containing a Wolf-Rayet star, is at 6.38 but no period is given. EM Carinae at 8.73 contains a pair of O8V stars with a period of 3.31427 days. GG Carinae, an EB/GS has the longest period of 62.086 days.

There is a project involving QZ Carinae on the website and with the advent of DSLR photometry it may be possible to complete this in the next few months. It's now ideally placed although eclipses may only be

measurable from mid-Pacific. But it's the out-of-eclipse light curve which is most interesting. We hope to determine a light curve for the non-eclipsing pair, the period of which is ~20.74 days, and which may well show ellipsoidal light variations.

There are 12 alpha Cygni stars - hot supergiants with non-radial pulsations - in the area. As would be expected there are some very luminous S Doradus stars as well - AG and HR Carinae and eta itself. Another very luminous star is V382, classed initially as a Cepheid but now seen to be a hypergiant star more like AG and HR with non-periodic brightenings.

The remaining variables are all low amplitude and erratic so not all that rewarding unless you have a particular interest in these. Strangely enough only one nova, RS Carinae, has been detected in the region.

The most studied star is, of course, eta Carinae. It forms a Y shape with theta, P and Q Carinae. Here we're looking at a massive hot star, almost certainly a binary with a very eccentric orbit, embedded in gas and dust nebosity. Regretfully it's not a suitable target for DSLR photometry - but it's still worth a glance every night, who knows, it may once again reach 1840s brightness!

EEB Project - SZ Piscium Summary for 2011 – *Margaret Streamer*

The eclipsing binary system, SZ Piscium, has been on the EEB (Equatorial Eclipsing Binaries) project list for a couple of years and finally we have some observations on the system, submitted by Neil Butterworth and myself. For more details on this intriguing system, refer to the piece I wrote in the last VSS Newsletter.

I used an SBIG camera and Neil used DSLR. My data are untransformed Vmag but Neil's data are transformed.

The measurements span from 29th October to 27th December, 2011, and as they were done late in the year, long time series results were impossible as the star was setting not long after the sun. Although I did time series on each observing night, during the 2-3 hours of data collection, the magnitudes remained essentially constant and are presented here as an average magnitude for each night. The only exception to this was on 22nd December where a slight increase in magnitude (7.348 to 7.314) was seen from the beginning to the end of observations. However, this data set was cloud affected for an hour in the middle of the observing session, so no continuous curve was obtained. So, the magnitudes are the average of the data at the beginning and again at the end of the observation session. Neil's results are single magnitude measurements.

Mid-point of observations (HJD)	V Mag	STDEV of mean	Predicted Phase	Observer
2455864.032540	7.474	0.019	0.13	MS
2455875.965825	7.465	0.012	0.14	MS
2455880.9512	7.397	0.030	0.40	NB
2455882.9103	7.310	0.028	0.89	NB
2455884.024841	7.464	0.016	0.17	MS
2455892.941201	7.503	0.006	0.42	MS
2455903.960068	7.454	0.012	0.20	MS
2455910.971024	7.793	0.042	0.97	MS
2455912.933525	7.504	0.029	0.46	MS
2455914.952039	7.781	0.020	0.97	MS
2455914.995183	7.806	0.026	0.98	MS
2455915.945698	7.434	0.024	0.22	MS
2455917.920638	7.348	0.049	0.72	MS
2455917.992698	7.314	0.031	0.74	MS
2455922.964653	7.770	0.024	0.99	MS
MS: Comparison star- HD 219018; STDEV – standard deviation of the mean of the data for each night's time series.				
NB: Comparison star- ensemble of 6 stars; STDEV- standard deviation of the zero point magnitude of the 6 comparison stars.				

Table 1: Summary of observations for SZ Psc in 2011

The predicted phase is based on the Krakow light elements for determining times of minima: $HJD = 2452500.60 + E \times 3.965694$. I never managed to catch the system going into or out of eclipse even though I collected data around the predicted minima for secondary and primary eclipses. All my results suggested that the star was already in eclipse ahead of the predicted ToMs. Given the paucity of the results, the time of minimum is impossible to determine but it would appear to be running about 0.04 days (almost 4 hours) ahead of the predictions for the primary eclipse.

Neil's data indicate that the star was not in eclipse at phase 0.89, whereas I measured the star already in eclipse at phases 0.97 and 0.98. One tenth of the period is 9-10 hours ($P=3.965$ days) so there is time enough for a primary eclipse to start between phases 0.89 and 0.97. Hopefully next season we can tie down the ToMs as those predicted on the Krakow website are obviously running later than the observed.

I present the few results graphically to get a better idea of the spread of the points.

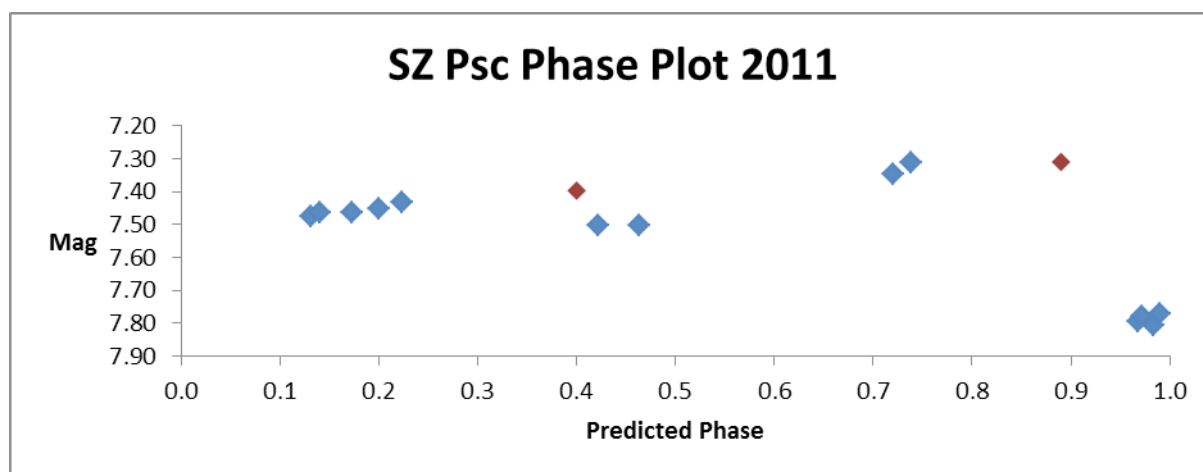


Figure 1. Observed V magnitude vs Predicted phase. MS: blue diamonds; NB: red diamonds.

The dip for the secondary eclipse is just about evident. My data are not transformed which could possibly explain the differences in magnitudes around the secondary eclipse (my $V_{mag}=7.503$ at phase 0.42 cf to Neil's of 7.397 at phase 0.40). However, based on the work I've been doing on SPADES targets my untransformed Vmags are less than 0.1mag different from the reported Vmag.

There has been some question about the variability of the comparison star I used and which Neil used as a check star - HD 219018, NSV 26038. This is reported on the AAVSO chart that I used as a suspected variable star. Jakate et al (Ref. 1) reported a 0.08 magnitude difference for NSV 26038 between two nights of observing, even though they mention that no variability was found in their earlier work. Percy and Welch (Ref.2) reported less than 0.01 magnitude variability over a several days for this star. This star is normally used for SZ Psc work (and there isn't any other choice in my CCD field) so hopefully the one discrepant reference can be disregarded.

So, more work is needed on this interesting system although we have to wait a few more months yet for it to re-appear in our skies.

References

1. Jakate, S.M., Bakos, G.A., Fernie, J.D. and Heard, J.F., *Eclipsing Binary System of SZ Piscium*. Astron. J. Vol 81, (1976) pp. 250-256.
2. Percy, J. R. and Welch, D. L. *Photometric observations of RS Canum Venaticorum stars*. JRASC. Vol 76, (1982) pp. 185-204.

It's Strictly Visual for Rod - an interview with Rod Stubbings

Some people achieve fame with years of dedicated hard work while others achieve it with a single act. Rod Stubbings is a man who can lay claim to both ways. After almost 19 years of dedicated visually observing the night sky Rod recently celebrated his 200,000th stellar observation for the AAVSO. Not only that but his 1999 observations of V4641 Sgr in outburst hit the headlines and caused professionals to slew their giant radio telescopes and the Rossi X-ray Timing Explorer satellite to track and observe V4641 Sgr. This system is now recognised as a microquasar housing the closest black hole to the earth.

VSS has interviewed Rod by email on the occasion of his 200,000th observation.



Rod Stubbings outside his Tetoora Rd Observatory in Victoria, Australia. Rod is presently building a new observatory and hopes to have this finished this year.

VSS: The majority of people who become interested in astronomy end up as ‘pretty picture’ imagers but you chose science. What led you to choose this path?

RS: When I first became interested in astronomy in 1986 I took to the stars every night and aimed to extend my knowledge of the night sky. After a while I found myself looking at the same objects each night and I became eager make my observing time more challenging. I attended a meeting at a local astronomical society and on that occasion Peter Nelson was giving a talk on variable stars and how observations can contribute to science. This appealed to me particularly because I would be making a contribution to science. So, armed with a beginner’s book on “The Observation of Variable Stars” from the Royal Astronomical Society of New Zealand I learnt how to make an observation on a variable star.

VSS: 200,000 observations in 18 years 8 months is an average of almost 30 observations per day. How much time on average would you spend on a clear night?

RS: Well, southern Victoria, Australia is known for cloudy skies so consequently I observe on every available clear night. In winter that means observing from 6:00pm onwards and up to 7 hours or longer with a few short breaks. In the summer it becomes dark at 10:00pm, so I will usually observe up to 6 hours. When there have been days of cloud and the following night is clear, I will usually observe all night. But, when there are consecutive clear nights I tend to just go through my list of stars and then either head off to bed, type up some observations or sometimes go straight to work!

VSS: You started out eyeballing stars and over the years you've moved to using various other optical instruments. How have your observing strategies changed over the years?

RS: L Carinae, a naked eye Cepheid, was my first observation which I followed for over 2 years. It didn't matter where I was I could always make an observation on this star. I tended to observe LPVs and a few of the well-known dwarf novae. The variable star section sent out a circular each month with all the stars that were observed so I began adding more stars to my list, especially the dwarf novae. Eventually I started to detect outbursts and I did not want to miss out on any!

I started to concentrate on many poorly studied and fainter dwarf novae after the request to do so from Frank Bateson. I would search through the catalogues and add all known dwarf novae along with suspected dwarf novae observable from my location. This involved a lot of stars which were having outbursts at magnitude 15.0 to 15.6. With constant monitoring I was recording their maximum brightness, frequency, duration and following the rise and fall of the outbursts. All this information was previously unknown.

Now with all the robotic surveys about these days I find myself looking for other targets. These are including the Symbiotic and Wolf-Rayet stars along with unstudied suspected Miras. I am now sending data to the professionals interested in these types of stars. Of course I won't stop observing the dwarf novae, after observing them for so long I can't just forget them.

VSS: How do you select stars for observation on any particular night?

RS: I have a list of over 200 stars that I observe on any given night throughout the entire year and I try to observe them all. I do this all from memory and star hopping so I don't waste time with finding charts. If I only have a few hours of observing or the clouds are rolling in, I select which stars I will observe first based on my feeling for which ones are due for an outburst, as well as the stars that I am forwarding data on to professionals.

VSS: Are there any observations (or sets of observations) that stand out in your mind?

RS: Yes, there are quite a few over the years. The notable ones are many of the first-ever visually detected outbursts of dwarf novae and supposedly non CVs. A few of these included CG CMa, V359 Cen, V591 Cen, LY Hya, OU Vir, DT Oct, FL TrA and V728 CrA. All of these stars were reclassified as new SU-UMa type dwarf novae. Another that comes to mind is V2051 Oph, which was an eclipsing dwarf nova. The ephemeris of the eclipses was 0.062427865d. On one particular night, during V2051 Oph's normal outburst of around magnitude 14.0, I followed two of its eclipses throughout the night and I observed an eclipse period of 0.0624d. I also detected the first-ever recorded superoutburst on this star since discovery.

However, at the top of the list it would have to be V4641 Sgr that stands out the most. In September 1999 an X-ray satellite was diverted to observe the star after I detected and reported an outburst at 8.8. The following night radio telescopes around the world were observing the object. The data revealed an X-ray binary system containing a black hole. To this day I am still the only person to visually see and record the 8.8 magnitude eruption.



NASA's Rossi X-ray Timing Explorer satellite was swung to observe V4641 Sgr following Rod's report of an outburst.

VSS: CVs can change their brightness quickly - do you ever just sit on the same star all night doing time series observations or do you always make one or two observations and then move on?

RS: Over the years I have constantly kept all CVs on my observing list for the purpose of getting to know their outburst behaviour. I can now determine if the outbursts are normal, superoutburst or in eclipse by their brightness. When I suspect the stars are in an eclipse I will observe them again and watch them rise. If I notice anything to be unusual I revisit the field to see if the outburst has brightened or faded. In the event of the outburst rising I make frequent observations during the night, especially for the rare ones to see what is going on.

VSS: Estimating errors and uncertainties is crucial to scientific work. How do you estimate uncertainty when you are just eyeballing a star?

RS: I have always been confident of what I see and detect. If there is any doubt I grab the chart to confirm. On the really faint fields I spend more time examining the angles and patterns until I'm satisfied. If it's an important outburst caught for the first time I will do a minor planet check.

VSS: What astronomical organisations do you belong to and where do you send your results?

RS: The Latrobe Valley Astronomical Society is a small club not far from where I lived, so I joined and attended their meetings. Due to my interest in variable stars I became a member of the RASNZ variable star section which you may now know as Variable Stars South. Furthermore, I am also a member of the AAVSO and all of my observations are now sent to the AAVSO's international data base. I still send outburst notifications to VSNET and CVnet and I also send my data to several professionals on certain stars to keep them up to date on their behaviour.

VSS: Have you ever been tempted to try CCD imaging?

RS: In 2006 I was offered and received a CCD camera from the AAVSO as part of a grant proposal from NASA. However, I did not have the proper equipment and I was in the middle of building my entire house, so the plan was to have another observer use the CCD camera until I was ready. Well, it's now 2012 and I have almost finished my house and my equipment is the same. The jury is still out on that one!

VSS: Does your passion for observing impact your work or family life?

RS: Admittedly it has been hard to find balance between observing, self-employment and family life (not to mention having four daughters)! But you somehow learn to adapt and work out an irregular system that includes all. For instance, taking two cars to family occasions so I can do a Houdini and sneak away earlier than others to get few observations in! Other times you just have to sacrifice a clear night for the family and unfortunately vice versa.

VSS offers it's heartiest congratulations to Rod and wishes him clear skies all the way to his millionth observation.

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.

WHO’S WHO

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Treasurer/Membership Bob Evans

Newsletter Editor Phil Evans

Webmaster David O’Driscoll

Visit our website to see a list of our area advisers, and to find out about our projects and how to contact their leaders

MEMBERSHIP

New members are welcome. The annual subscription is NZ\$20, and the membership year expires on April 30th. Find out how to join by visiting the VSS website. There you will find out how to join by post, email, or directly online. If you join by email or online you will get a link to pay by PayPal’s secure online payment system, from your credit card or bank account.

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

NEWSLETTER ITEMS

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

Publication dates are February, May, August and November, nominally on the twentieth day of these months and the copy deadline is the thirteenth of the month though earlier would always be appreciated.

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