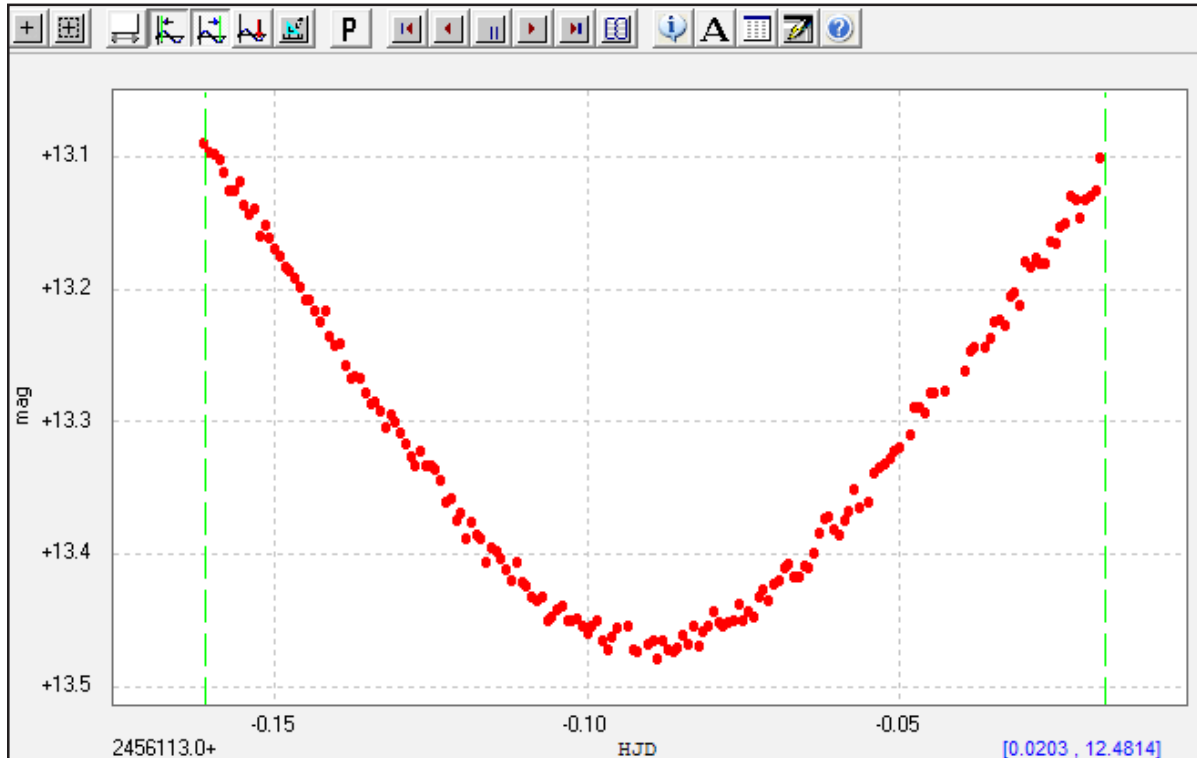
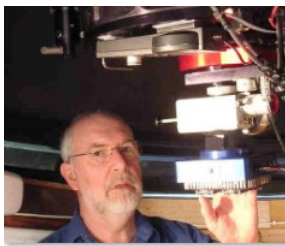




A beautiful eclipse of BE Cru obtained by David Moriarty as part of the SPADES campaign. See Tom's update on The SPADES program beginning on page 18 of this issue.

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From the Director – *Tom Richards*

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Meetings and More Meetings

Variable star work can be an isolating experience. Most of us work alone, and have no other variable star people nearby. Modern internet communications help, but the high-power experience is to spend a day or two sharing knowledge and experience with fellow VSOers. So do think and plan how you can get together with others in a variable star meeting. Here's what's coming up in the next year or so, in chronological order.



SPADES workshop, Canberra

Active participants in the SPADES project are meeting in Canberra next March 16-17 with sleeves rolled up to work on a range of issues. Margaret Streamer is coordinating the weekend, and had the idea in the first place. If you have been active in the project and haven't been contacted (nobody surely!) please email me.

AAVSO Spring Meeting 2013, Boone, North Carolina, USA

To be held at the Appalachian State University on May 17-18, 2013, it's the major conference of the year for variable star researchers. It shouldn't be too hard to get there from this part of the world. Keep an eye on <http://www.aavso.org/aavso-meetings> for upcoming details.



RASNZ 2013, Invercargill, NZ

The conference is being held in Invercargill, which I think is part of the NZ Antarctic Territories, at the Ascot Park Hotel on May 24-26, 2013, a week after the AAVSO conference. There is no VSS meeting attached to this, so the idea is to flood it with variable star presentations – posters or talks. What will you present? Visit <http://rasnz.org.nz/Conference/>. And our own Bob Evans is giving the Fellows' Lecture – not to be missed!



NACAA XXVI 2014, Melbourne, Australia

Slated for April 18-21 2014 (Easter), there are no venue details yet. Again, we aim to make variable stars very prominent in this conference. Easy to get at from NZ, or anywhere, this should attract a lot of overseas visitors, all with variable star papers in their pockets. Go to <http://www.nacaa.org.au/>.



RASNZ 2014 and VSSS3, Whakatane, NZ

Shifting venue from the Frozen South to the balmy Bay of Plenty, this conference will have the Variable Stars South Symposium #3 attached to it on the Monday June 9th following the conference weekend, Fri-Sun 6-8 June 2014. I'm giving plenty of



advance notice here, because of our symposium, which I hope will get even more than the 30 attendees at the last one in Brisbane.

What could you present at these conferences?

NACAA and RASNZ conferences, as well as AAVSO, are primarily amateur in terms of attendees, but aspire to the reportage of serious research amongst amateurs and professionals alike. But standards are flexible – it's more important to have many presenting their exciting work than to set a forbidding bar at a professional level.

Posters lend themselves to reports on projects, or a summary of your work on individual stars, as well as overviews of techniques. Col Bembrick recently did an excellent poster on using the BinaryMaker 3 program to analyse eclipsing binaries. Anything from a couple of nicely-prepared A4 sheets upwards – with plenty of visuals! Most people don't stop to read the fine print – these are posters not theses nailed to the door.

Paper presentations are usually 15-minutes of talk using PowerPoint then 5 minutes discussion. Again, topics can be variables you're studying (a story often makes a more interesting talk than presenting bare results), projects, instrumentation and techniques. At the last NACAA there were some fascinating presentations on spectroscopy, and VSS members are developing and applying interesting new techniques in the DSLR world too. Or give a talk about your area of interest in variables, why it matters, and what needs to be done, and the astrophysics. This old pro's advice for slides is one a minute, and as few words as possible (never read out a slide, talk around it – it's there to illustrate what you say). These conferences don't require you to have a written paper – just to have an abstract and make the slides available for the conference DVD.

So start thinking of a topic that interests you now, and work it up slowly. See you there!

VSS Grant to David Moriarty

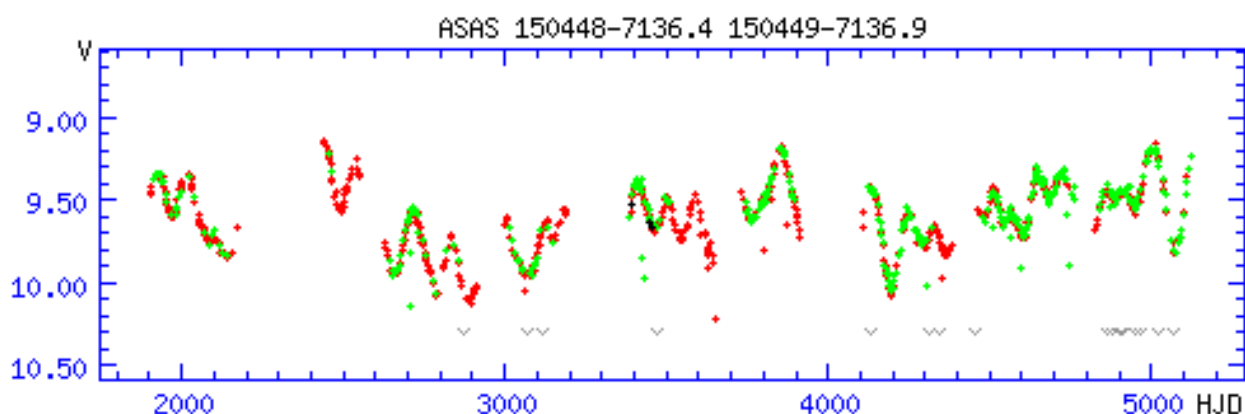
David's work for SPADES is becoming a legend – and he only started variable star research a couple of years ago. To improve the already high quality of his observational data he decided to use PEMpro (<http://www.ccdware.com/products/pempro/>) to minimise periodic error. A good use for VSS funds.

We have a reasonable amount of grant money available, so if you're a member why not apply for some? See Community > VSS Research Grants on our website.

During the period 1969 to 1990 many thousand of UBV measures of assorted variables were made by the Auckland Photoelectric Observers' Group (APOG). When I have time I'm collating these and transferring them to the International Database operated by the AAVSO. Recently I have been assembling measures of some RCrB stars, mainly S Apodis and UW Centauri but with a few from RZ Normae and Y Muscae - 324 in all. These stars have small UV excesses when at normal magnitudes but redden strongly during the fades when they're obscured by dust ejection, and remain so during much of the rise to normal brightness.

Most observers are interested in the spectacular fadings of these stars but they usually show fairly regular pulsations. One of the first analysis papers published by the VSS RASNZ, Waters, 1966, looked at the accuracy of visual measures of S Apodis and detected a 120 day period.

Sometimes if another variable is close we include that when observing and I found four measures of V Apodis. A check with the GCVS indicate that it was an Lb star which could agree with the average V magnitude of 10.140, B-V 1.710 and U-B 0.806, but the strong UV excess indicates a rather more active star. This was confirmed by the ASAS-3 light curve



ASAS 150448-7136.4 Light Curve of V Apodis (ASAS-3)

There is a strong periodicity at 96.13 days with others at 130.18, 143.21 and 297.34 days. Hence the rather messy light curve. There is probably a mix of aliasing and multiple modes here.

I was rather more surprised when looking at the Tycho catalogue data in Guide 8 to see that it's given an absolute magnitude of 6.9 ± 1.3 and a distance of 32 ± 19 pc. This is hard to match with the colours, the spectral class of Mb and the SR pulsations. The ASAS curve suggests the possibility of a long term variation with a period around 1800 days but due to the different reduction techniques and the short baseline that's doubtful. ASAS has done a good job here - no real need for further measures. But a search of the GCVS lists of SRa stars and matching ASAS-3 light curves may reveal other interesting objects.

Reference

Waters, B H J 1966 RASNZ VSS Circ 119 Statistical analysis of observations of S Apodis

Identifying NAV stars in the list of Innes variables – *Mati Morel*

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I have a long-standing interest in the work done by R.T.A. Innes and his colleagues at the Union Observatory, Johannesburg, South Africa.

Robert Thorburn Ayton Innes (10 November 1861 - 13 March 1933) was born in Edinburgh, Scotland, the eldest of 12 children. He had very little formal education, leaving school at age 12. He had no formal training in astronomy but was an exceptional mathematician and was elected a fellow of the Royal Astronomical Society on 10 January 1879, before he had turned 18. After marrying he moved to Sydney, NSW where he became a successful wine merchant. However his real passion was astronomy, particularly theoretical aspects and double stars. By using a borrowed 6¼ inch refractor with a crude mount, he had discovered 26 new pairs by the early 1890s. These were published in a first list in December 1894. Though an amateur, his ability in astronomy was soon recognised, so he decided to forego the wine business and make astronomy his career. As a paid position in astronomy could not be found in NSW he approached the Royal Observatory at the Cape of Good Hope and was eventually offered a fairly humble post as a secretary-cum-librarian-cum-accountant by David Gill, the director. At least this allowed him to pursue his own research in his free time. In 1896 he moved to South Africa permanently.

In 1903, on the recommendation of Sir David Gill, Innes was appointed director of the new Transvaal Observatory at Johannesburg. The observatory was initially dedicated to meteorological work, but under Innes' direction it branched into astronomy and in 1912 it became known as the Union Observatory of South Africa. Observational programmes concentrated on double stars, proper motion studies (Proxima Centauri was discovered in 1915), phenomena of Jupiter's satellites, and positional measurements of comets and minor planets. The copious measurements of all kinds filled many pages of the observatory's bulletin, the Union Observatory Circular, commencing on 1 October 1912.

Contributions were also made to variable star research, beginning in 1914. Many of the early discoveries were made using a blink-microscope, in which plates taken at different epochs were alternately compared in rapid succession. Any star which changes its position or brightness is immediately revealed. In UOC20 the first list of new variables was published by Innes (1914).

I began to look closely at the variable star reports from Union Observatory about 15 years ago. It is clear that over time the method used for finding new variables at UO had changed. In the first list of Innes (1914) the plates he used were all of the same type and fairly homogeneous. Within the same decade Worsell (1919) published his own list of discoveries based on a mixture of plates from different observatories, and the emulsions were doubtless by different makers and of differing response characteristics. This resulted in a high proportion of false detections of variability. Many of these false variables are red stars and, notwithstanding their lack of true variability, received VS names at least 90 years ago. Nine of Worsell's stars were measured in BVRI (Morel and Di Scala 2007) showing that their brightness was constant or near-constant. Worsell's detections of variability must have been instrumental in nature, not real.

The main failing in the VS work at UO was the manner in which the discoveries were published, with only very approximate coordinates and very rarely with good-quality finder charts. Most of the early finds were stars of large amplitude (Mira and other long-period types), which were recovered by later work at other observatories with little difficulty. I recently took a close look at the list of variables by Innes (1914), as about 30 of his finds were still uncertain, having only NSV numbers which indicated lack of verification nearly a century after being first reported. The work done to identify these stars successfully forms the basis of my paper "Identifying NSV Objects in the List of Innes Variables". This provides identifications and precise positions, and confirms the variability of many objects.

The paper can be downloaded as a PDF from the VSS website, by going to <http://www.variablestarssouth.org/index.php/all-jdownloads/viewdownload/121/986-identifying-nsv-objects>

TABLE 1 : Identification of Innes Variables with NSV Stars.

Innes	J2000	S	NSV	GCVS	Remark	Plate No.
2	* 18 25 05.48 -31 31 12.3	M		V929 Sgr	NSV 10743 (alt. id.)	1
3	* 18 26 27.31 -33 03 37.6	M	10783			2
5	* 18 27 05.33 -29 03 15.2	U	10802		SR	3
9	* 18 29 12.38 -35 22 30.7	U	10867	V3418 Sgr		4
21	* 18 33 29.31 -30 34 12.2	M	11004		SR	5
32	18 36 23.07 -32 38 28.4	M	11073	V4147 Sgr	RRab	6a,6b
38	18 38 21.42 -36 35 22.9	U	11120	V946 Sgr	M	
39	18 38 17.1 -31 05 53		11123		Id. not possible	7
42	* 18 39 23.95 -28 40 10.1	M	11150			8
52a	* 18 42 50.84 -33 19 36.3	U	11220			9a,9b
59	* 18 45 16.25 -33 33 29.5	U	11277	V1210 Sgr		10a,10b
62	* 18 45 18.48 -32 11 06.6	U	11286			11a,11b
64	18 45 50.28 -32 16 26.3	M	11298	V5543 Sgr		11a,11c
79	* 18 55 27.35 -26 41 44.9	U	11517			12a,12b
82	* 19 00 49.48 -25 53 43.5	M	11633			13a,13b
83	* 19 01 11.91 -27 38 51.3	M	11638			14a,14b
103	* 19 16 16.61 -27 18 12.5	M	11851		SR	15
108	* 19 33 47.69 -36 38 47.3	U	12127			17

Notes:

Asterisk indicates a new/improved position.

S = Source

M = 2MASS

U = UCAC3

At the time of its founding UO was some way out of Johannesburg, and could take full advantage of the clear dark skies which its location offered. In fact, in 1903 UO was so far out of town that cab-drivers refused to go so far into the country after sunset. Much has changed since then. The circulars continued to be published up to the 1950s; no 113 was issued in June 1953 June. The name of the observatory was changed to “Republic Observatory” in 1961, by which it was referred till 1971 when it was closed.

R.T.A. Innes retired from the directorship in 1927. He died suddenly of heart failure on 13 March 1933 at Surbiton, near London, England.

References

- Anon. 1933, Observatory 56,129
 Anon. 1934, Mon. Not. r. ast. Soc. 94,277
 Innes, R.T.A. 1914, Circ. Union Obs. No.20,149
 Morel, M. and Di Scala, G. 2007, J. Amer. Assoc. Var. Star Obs. 35,366
 Worsell, W.M. 1919, Circ. Union Obs. No. 46, 15

Update on the Dual Maxima Mira project – Stan Walker

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When this began several years ago we compiled a list of known dual maxima stars as well as some possible additions. There were four main stars: the prototype R Centauri, R Normae, BH Crucis and V 415 Velorum, then known as NSV 4721. To these we had added another eight possibilities. These four stars have been defined by light curves of the type shown in Figure 1, that of R Normae for the 2000 days up to 23 November 2012.

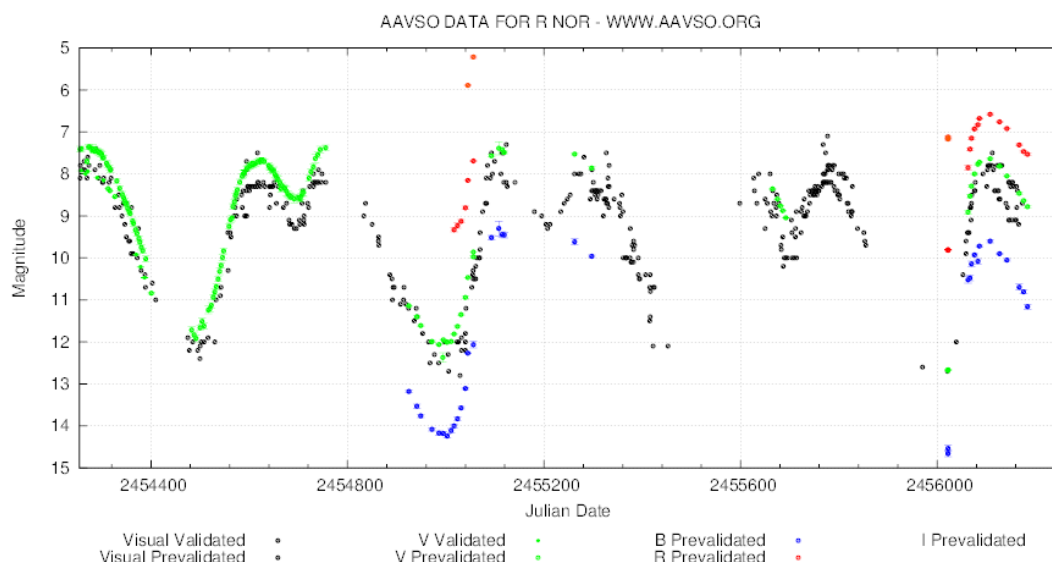


Figure 1. BVRi measures of R Normae along with standard visual estimates. The largest amplitude is through the B filter but the star is brightest in I and even brighter in J and H for which there are no measures. There is still some uncertainty as to which is the brighter of the two maxima. Note the colour coding of the BVRi measures which applies to all the International Database plots.

Most of these objects appear to be in the southern sky but there are strong indications that T Cassiopeia may be such an object.

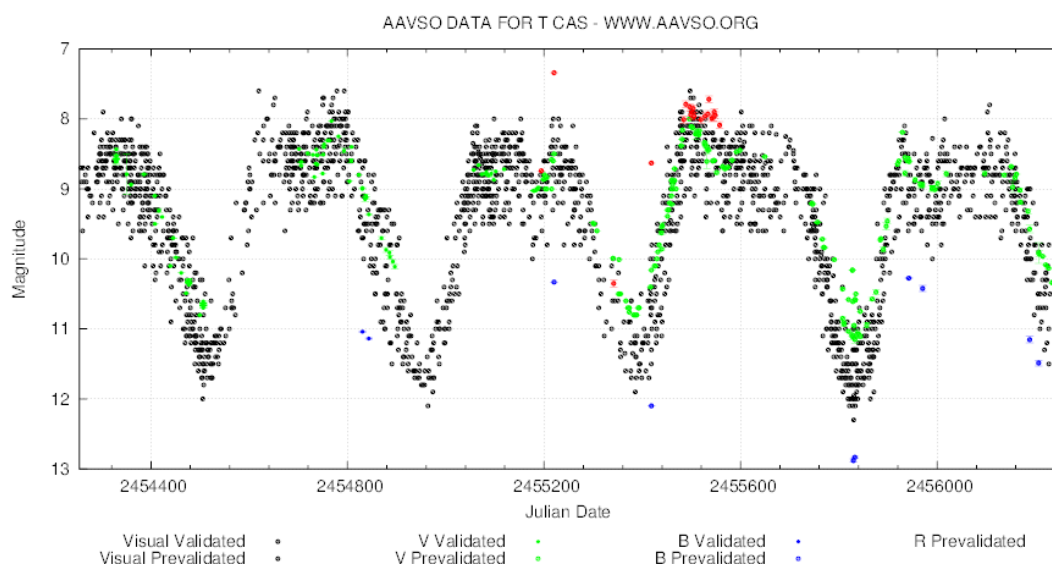


Figure 2. BVR measures of T Cassiopeia superimposed on the visual light curve. The green V measures show indications of a dual maxima but are too sparse to be certain. Over the past few decades of visual measures there are some clearly defined double maxima - but also some where the first maxima is considerably smaller than the second.

The last 2000 days from the International Database show the steep rise and final fall. The wide maximum shows a scatter of almost two magnitudes in the visual measures but the more precise V measures show some evidence of a dual maximum. The period of 445 days seems within the range of these stars. At 55°N it's out of range of many of our observers. Like BH Crucis it has a rather unusual spectrum but its amplitude is larger and the colours less extreme.

Observers are now looking at some of these stars with a variety of filters, mainly BVRI but there are one or two JH measures although they are rather random. In Figures 3 and 4 the light curves for the two stars with changing or changed periods, R Centauri and BH Crucis, are shown. The period of R Centauri appears to continue to shorten and the secondary maximum may be recovering to its original strength. BH Crucis has some beautiful BVRI measures and a few JH observations – the cerise and pale coloured measure in the last maximum. It's an unusual star for a Mira in that the JH bands are relatively weak.

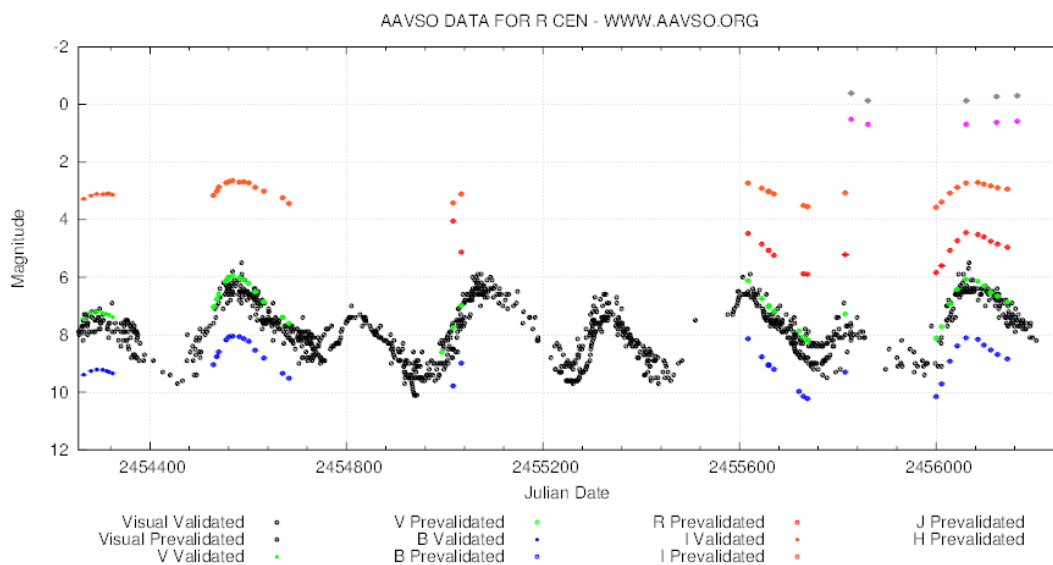


Figure 3. BV and visual measures of R Centauri would be nicely supplemented by some RI for a cycle or so. It's probably also very bright in J and H if it's similar to most other Mira stars. The last maximum interval was short but the preceding one rather long. Over the interval shown the mean period was 498 days so it still seems to be decreasing.

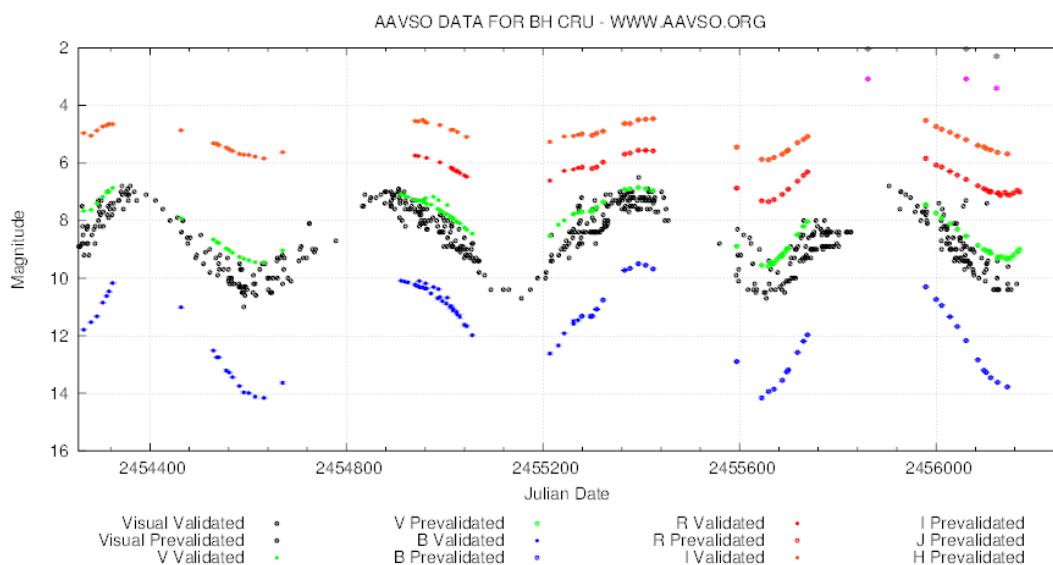


Figure 4. The period of BH Crucis seems to have stabilised in the 510-525 day range but its first maximum is now almost non-existent. It's still faintly visible on the rising branch in the third of these cycles, particularly the BVRI measures. The B-V colour is similar to what it was when measures by di Scala and Williams/Walker were made about a decade ago. Giorgio di Scala and Neil Butterworth have been measuring in BVRI with a few JH by di Scala.

Another star of interest is V415 Velorum. This is noted in the GCVS as an SRa star with a period of 414 days. Peter Williams drew my attention to this many years ago. It is clearly a dual maximum Mira as shown by the ASAS3 light curve. This incorrect description, based upon its supposed amplitude of <2.5 magnitudes also appears in the AAVSO VSX register and this has possibly discouraged measures. Varying between 9.9 and 12.8 it is no less regular than most Mira stars. Colour photometry will reveal whether the low amplitude is caused by a companion star or extreme colours as with BH Crucis. The spectrum of Se suggests a rather red and cool object with, perhaps, not such a strong signature in J and H.

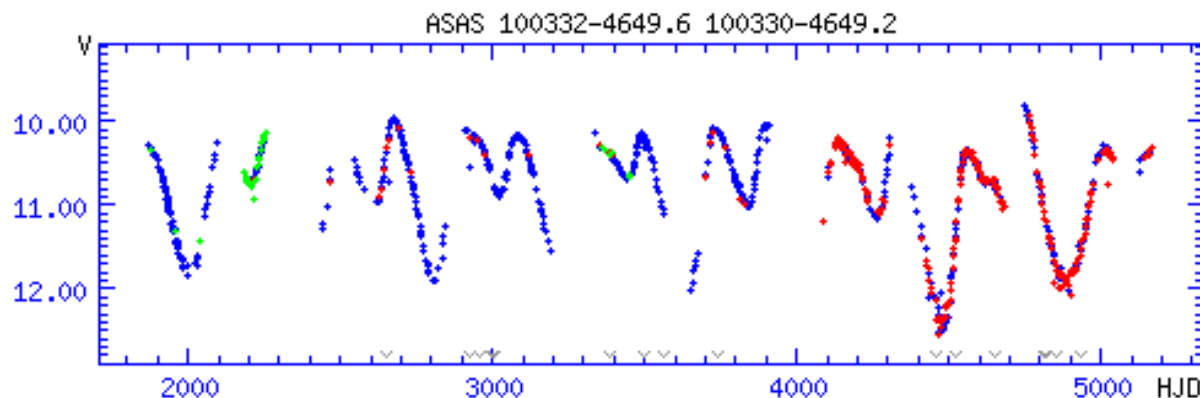


Figure 5. Measures over 3300 days by ASAS-3 of V415 Velorum show a beautiful dual maximum star - but with a fairly low amplitude. These measures are through a V filter but with no transformations made so are probably $\pm 2-3\%$.

There are 262 visual measures of V415 Velorum available. These are shown in Figure 6a and 6b below. At the left they are presented in JD order and several minima are clearly defined. The dual maxima are hard to recognise on that scale. When folded with a period of 413 days the dual maximum is clear, with some scatter. A check of the field reveals a $\sim 12^{\text{th}}$ magnitude star about $90''$ NE of the variable which may confuse observers at times. Be careful.

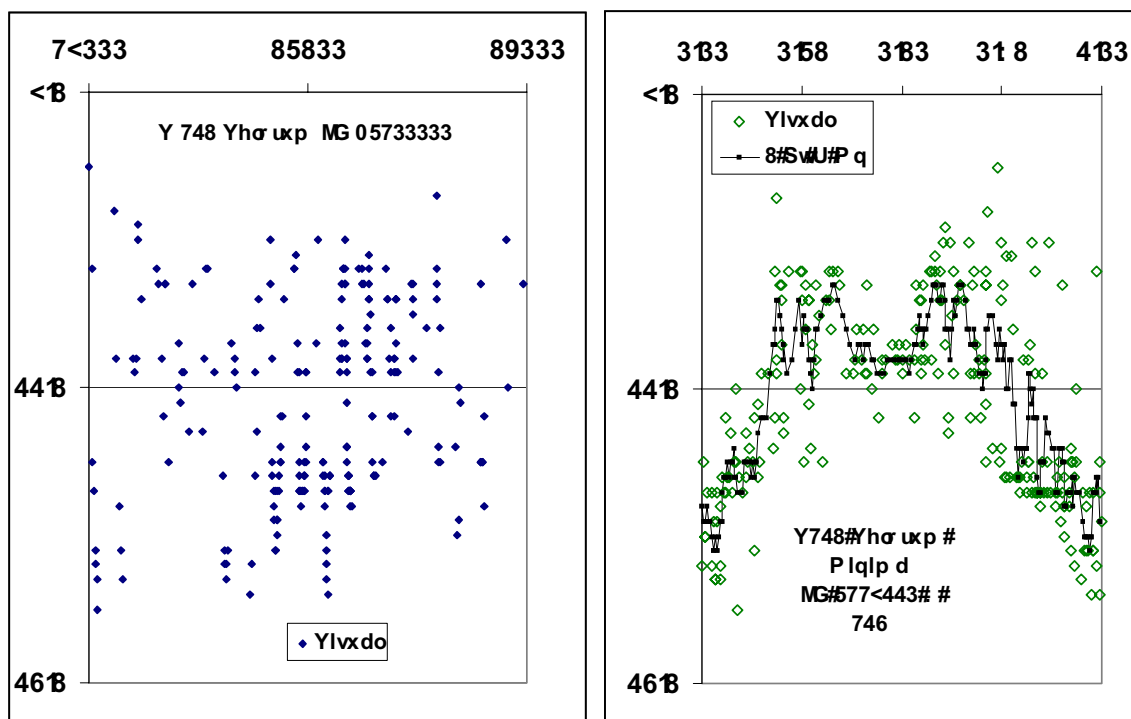


Figure 6a,b. This shows on the left all the visual measures of V415 Velorum, an interesting object requiring some BVRI photometry to add more information about its physical nature - temperature, how this varies during a cycle, is it changing? The visual observations are largely by Peter Williams and Alan Plummer. In the right hand graph, folded to the period shown, a 5 point running mean has been superimposed to make the duality of the double maximum slightly clearer. There are about 12 cycles involved and Miras are not very repetitive pulsators, hence the scatter.

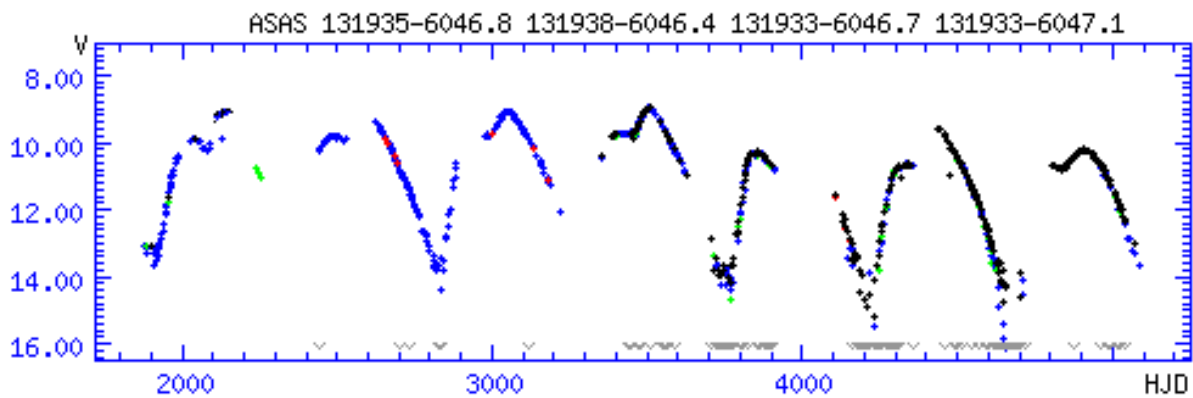


Figure 7. ASAS-3 measures of TT Centauri are shown. The duality is clear, although the overall light curve shape differs from R Normae and V415 Velorum.

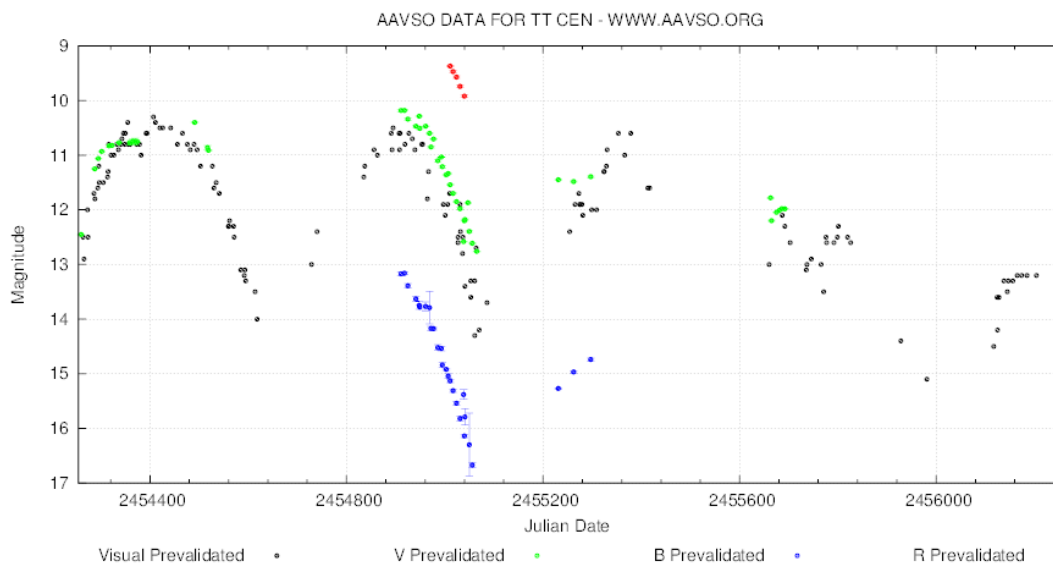


Figure 8. Measures of TT Centauri during the last 2000 days. The first two cycles overlap the ASAS-3 data but the last three have not been well observed. They seem to show decreasing brightness at maximum. Some BVRI measures of this star would be very informative.

All of the true dual maxima Mira stars have periods of more than 400 days. Of those known, two have changed periods; R Centauri, where the period is growing shorter and the shape of the light curve is now markedly different with a much deeper secondary minimum; and BH Crucis where a dramatic change of period from 421 to 525 days over less than two decades has been accompanied by a brightening and cooling of the star.

The colours give an indication of temperature and any changes therein. B-V is the best but since B can be faint V-R is a useful substitute and more readily measured, particularly by DSLR exponents at maximum. Unfortunately the V-R colour index is only about 52% of the B-V but changes during a cycle are quite clear. A measure every 20-30 days with these slowly varying stars is quite adequate. R Centauri is approaching a secondary minimum so measures for the next year would be interesting to see how the light curve shape and colours are changing.

There are many other Miras with periods in excess of 400 days and some, such as R Hydrae and LX Cygni have undergone period changes. The visual observers will keep on top of any change in the period but there is value in colour photometry of a cycle each decade or two, so try to get a few BVR measures of some of these.

The other possible stars in this group have so far shown that they are semi-regular variables with no consistent light curves. But the dual maxima phenomena must have some reason - those put forward to date by analysts seem implausible - and since this group seems prone to period variation continued measures are valuable.

HD 5980 a boring name for a star system that is anything but – *Glen Schrader*

On 19 October 2012, an alert notice by Dr Noel Richardson was issued through the AAVSO for multi-wavelength monitoring of HD5980. This system is described in the VSX as an “EA/GS/WR+SDOR”. What does this alphabet soup mean?

Richardson describes the system as such: “HD 5980 is an eclipsing binary in the Small Magellanic Cloud. The system consists of two massive stars each with a strong wind. The primary star is a luminous blue variable (LBV) and is unstable, having erupted in the 1990s to become the visually brightest star in the SMC. The secondary star is a nitrogen-enriched Wolf-Rayet star (WN). The orbit is slightly eccentric with a short 19.3 d period. As the stars orbit each other, their strong winds collide, bringing about changes in multiple spectral lines, small changes in the brightness of the system, and strong X-ray modulation.”

The following eclipse predictions were also given in the alert:

Primary (JD)	Secondary (JD)
2456220.8 (2012 Oct 20)	2456227.7 (2012 Oct 27)
2456240.0 (2012 Nov 8)	2456246.9 (2012 Nov 15)
2456259.3 (2012 Nov 27)	2456266.2 (2012 Dec 4)
2456278.5 (2012 Dec 17)	2456285.4 (2012 Dec 24)
2456297.8 (2013 Jan 5)	2456304.7 (2013 Jan 12)
2456317.0 (2013 Jan 24)	2456323.9 (2013 Jan 31)

These predictions and the accompanying 19.3 day period suggest some uncertainties in the elements. A quick look on the VSX gives 2443158.77 + 19.266 days

Further scanning of several early papers on this star turns up primary minimums from Smith 2438927.467, Hoffman 2443165.45 and Breysacher 2444158.772 +19.2655 days. The VSX elements are obviously those of Breysacher

Plotting ASAS data with the Breysacher epoch gives the light curve in figure 1. The data labelled as “original PEP” is the combined measures from Smith, Hoffman and Breysacher.

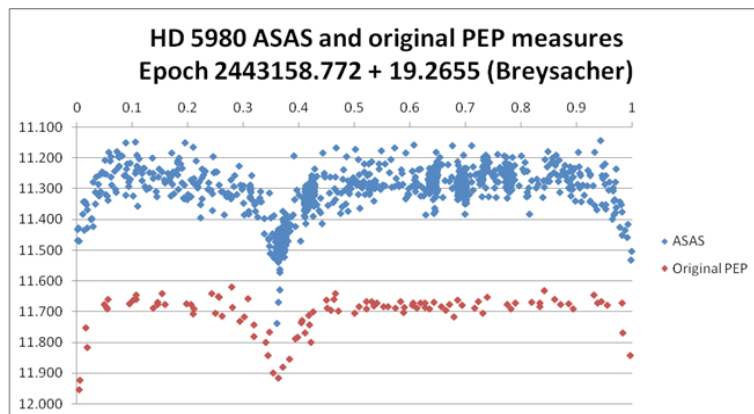


Fig 1. Light curve using ASAS data (blue) and combined data from Smith, Hoffman and Breysacher.

The period looks quite close, however the ASAS data is running a little early. Using one of the primary minimums from the AAVSO alert notice produces a near identical plot (not shown) so it is probable that the Breysacher elements are being used. Some features that can be determined from the lightcurve are that the system is quite eccentric and that the eclipse depths seem to be different when compared to the earlier PEP results. In general ASAS data is better than this at these magnitudes so some of the noise may be due to various out-of-eclipse variations. A major outburst was noted during the 1990s for this system and so the scatter may partially be due to the recovery of the system back to a lower state over time.

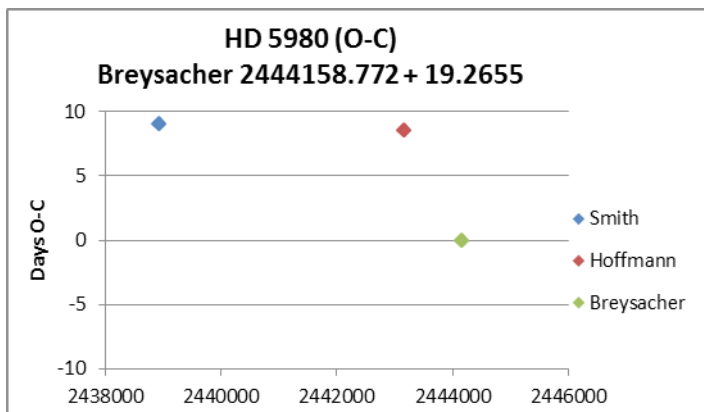


Fig 2. O-C diagram for HD 5980.

system with stars exhibiting mass loss and so it is possible that the eclipse depths are changing as a result of the various interactions. During further analysis, I have decided to stick with the primary as defined by Smith and suggested by the ASAS measures.

To refine the period the ASAS data was split into three discrete time periods and an epoch of minimum identified for each. Epochs of 2453607.711, 2454705.755 and 2456227.606 were determined. In addition, revisiting Breysacher's data, a minimum from his secondary eclipse has been determined and has been placed on a revised O-C diagram (Figure 3).

Regressing the cycle numbers against these six data points confirms the period determined by Breysacher at 19.2655. The three ASAS epochs suggest that the period may be 19.2654 however, this would need to be confirmed using more recent measures.

Since the posting of the AAVSO alert notice Franz-Joseph Hambach (FJH) and Terry Bohlson (TB) have been making BVRI measures. To compare how these results fit with the data outlined to date I have plotted these recent V measures onto a revised lightcurve in figure 4 below. To make it easier to compare the two eclipses the phase is offset by an arbitrary amount.

You can see that the three data sets are displaced substantially in V, which may be a combination of outburst activity and filter/transformation issues.

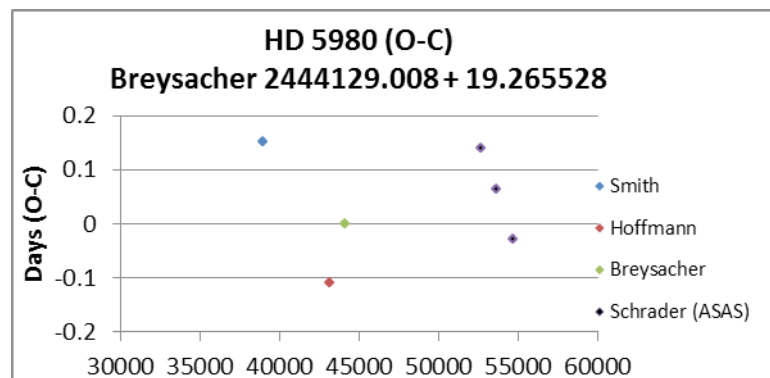


Fig 3. Revised O-C diagram.

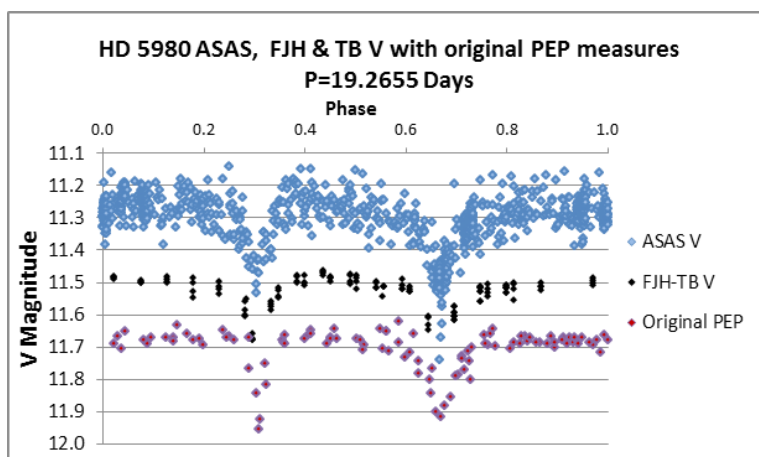


Fig 4. Revised lightcurve

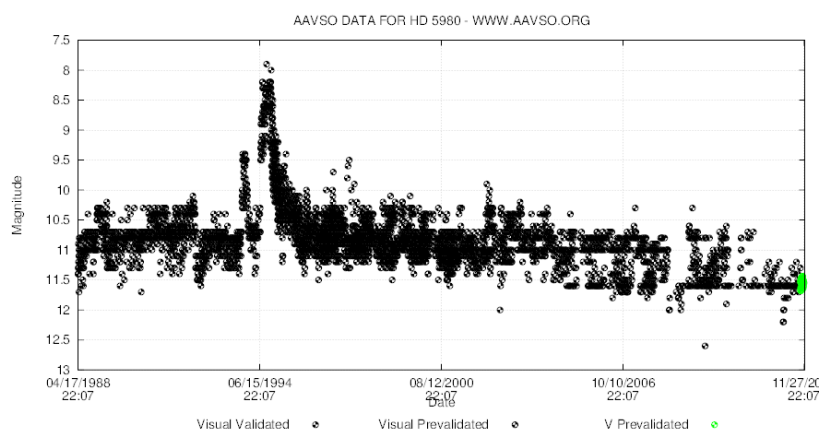


Fig 5. Historical AAVSO data for HD 5980

The AAVSO International Database has a long history of visual measures for this system with the majority of these being from VSS members going back to the beginning (over 90%). The outburst mentioned is clearly visible in the data shown in figure 5. There has been a gradual decline since this time with other probable short period variations superimposed. The fading since 2000 certainly may explain the difference between the ASAS and recent V results.

To make it easier to see how the three curves fit together the ASAS data and original PEP have been roughly transformed onto the recent V measures in Figure 6.

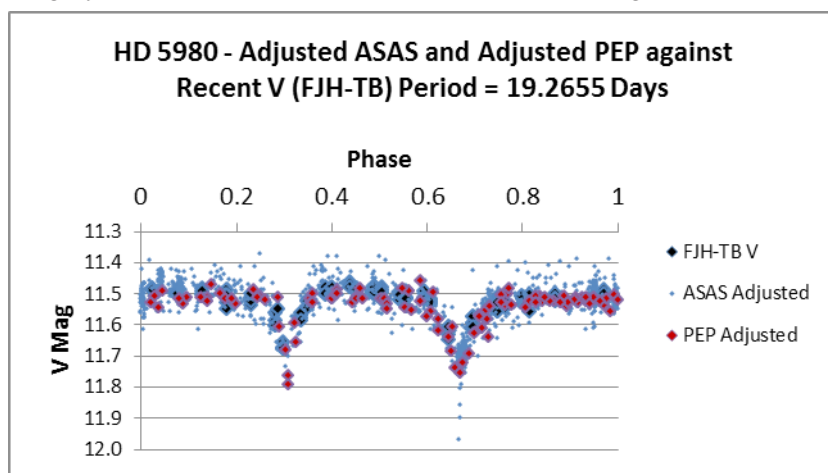


Fig 6. Light curve using adjusted ASAS and PEP data

We can see that the period fits well and in general terms the three sets of measures match in terms of light curve shape. What is needed from here is to continue the intensive multi band photometry of this system as per the AAVSO alert notice with particular attention given to the eclipse periods. To nail down the period and the current eclipse depths there is a need for time series photometry at these times. As it stands an updated ephemeris using the above analysis (for this season) appears below. Given the confusion over which eclipse is the primary, equal attention should be given to both eclipses.

Primary	Secondary
2456285.539	2456297.791
2456304.804	2456317.057
2456324.070	2456336.322
2456343.335	2456355.588
2456362.601	2456374.853
2456381.866	2456394.119
2456401.132	2456413.384

Finally it will be important to continue the excellent visual work that has occurred since the late 1980s. This system will surely continue to display short outbursts and who knows, it may once again put on a display as it did in 1994!

References

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 AAVSO International database
 ASAS Photometry database

Astronomy 3.0 – Peter Lake

Astronomy is just awesome. The thing that intrigues me the most is, we can't touch it, we can't change it ...it's just out there, in all its glory, we CAN but look ... and measure!

It's my view that astronomy is the purest form of the scientific method, competencies like photometry, astrometry and spectroscopy are performed over and over by amateurs and professionals alike, and the data is made available to all through our hard work and the database managed by the AAVSO for peer review and the inclusion in science papers the world over.

Passionate people who want to reach out and measure the untouchable, the unreachable, make sense of it, and share it with others – these are the astronomers.

I fell in love with astronomy in my teenage years, but like many, got distracted and busy with other things in my adult life. In 1975, I lay awake in the backyard counting meteors at 1am in the morning. I had a book by Patrick Moore called Southern Astronomy and I was waiting for my first meteor shower.

But who could I tell? There was no internet! The only (very few) astronomers in the country at the time, didn't want to know there was a 15 year old boy in a sleeping bag counting Orionids. Who really cared?

I was a 1.0 Astronomer.

The 1.0 Astronomer is the lonely person at the top of the hill doing science at the eyepiece. New technology was glass plates that could be flipped to see if a “star” had moved from night to night. Astronomy was a very exclusive and dedicated pursuit that involved long periods of solitude on cold and lonely mountaintops.

Around the early 2000s or the “noughties”, something happened - a game changer. The internet arrived. Part of the story of the internet involved astronomy. In 1977 John O'Sullivan at the CSIRO was leading a team exploring the use of Fourier transforms to remove noise from radio astronomy signals. By 1996 this work had matured to the point where O'Sullivan and his team were able to file a patent for reducing interference in multipath signaling. In 2011/2012 CSIRO were awarded \$430m in royalties, as this technology was now an integral component of the 802.11 Wireless standard.

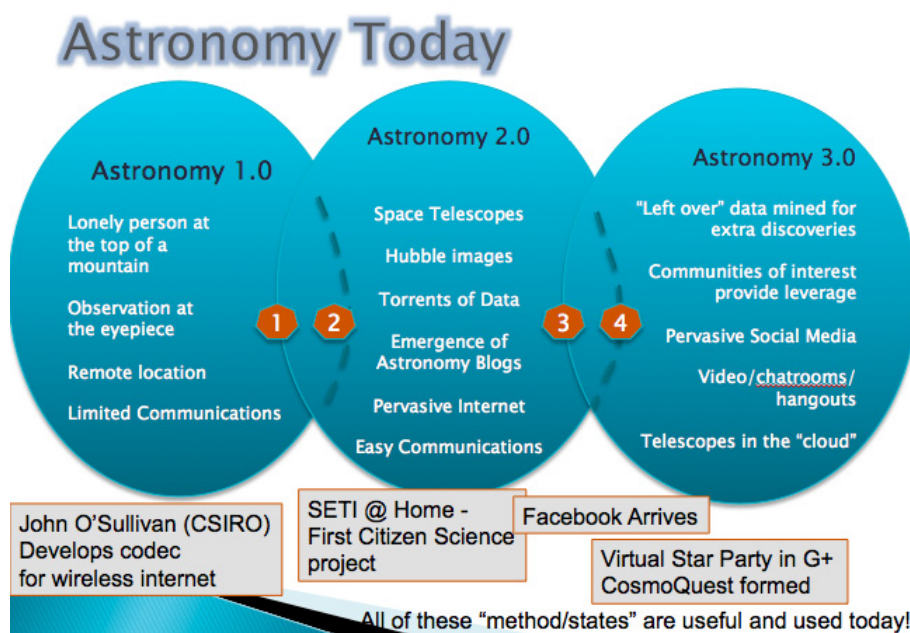


Fig 1. The three paradigms of modern astronomy

The internet was here! The next change was the arrival of citizen science.

Now that computers were becoming more affordable, people who had one naturally felt more “geeky”. In 1998 computer scientists and researchers David Anderson and Dan Werthimer at U C Berkeley approached the Planetary Society with an idea – why not make these new-fangled screensavers do something useful –

ahh ... like search for extra-terrestrial intelligence. By 2012 over 6 million “citizen scientists” in 226 countries had processed petabytes of data. The simple \$50,000 investment had tapped into the motherload, of what is called today - “crowdsourcing”.

When my Dad passed away in 2003, I reflected (as we all do at such times) on what was important and what dreams I had achieved. It was then I reconnected with my passion. As a SETI@Home user, I looked around for what else was out there (pardon the pun) and I found a new citizen science activity called the FMO Spacewatch programme funded by the Paul Allen foundation and administered by the University of Arizona.

The cunning plan was to take 600 mosaic photos per night of three frames per field, and present them as blinked images to a team of volunteers, who had completed a short tutorial and passed a test, so that they could point out anything of interest to the team of professional astronomers. Observers were to look for long streaks – or Fast Moving Objects that could be

Peter Lake is an IT Service and Support Manager and Amateur Astronomer.

- 32 Years experience in Telecommunications, Data Networks & IT
 - A member of AAVSO and VSS attended the Centenary Meeting of the AAVSO in 2011.
 - In 2004 he recovered 2000 EV70 (162422). As a Spacewatch volunteer: MPEC 2004-E11
 - He is an affiliate of iTelescope.net
 - Co-authored two papers:
 - Long term variability and outburst activity of FS Aurigae: further evidence for a third body in the system, *Neustroev, 2011* and
 - Photometrical observations and time transit variations (TTV) researches of extrasolar planets, *Sokov, 2012*.
-

followed up quickly, to determine how many small asteroids were approaching the earth.

On March 3rd 2004 I was the volunteer who recovered 2000 EV70, now numbered object (162422), the first PHA (potentially hazardous asteroid) to be picked up by the programme. That got me excited, it was one item on my teenage bucket list – to make a scientific discovery.

Now that computers were pervasive, citizen science had arrived, people started to blog! The Astronomer was no longer the lonely person at the top of the mountain, he/she had access to information, could share alerts, could get help instantly. Bloggers such as Phil Plait, Chris Lintott, Pamela Gay, (all PhD Astronomers) and Fraser Cain, editor of Universe Today started stimulating community interest in astronomy. A popular theme that lived really only in the PowerPoint presentations of telcos and service providers - the “Community of Interest Network” (COIN) came to the world of astronomy, and I like to think of it as Astronomy 2.0.

Space telescopes like the Hubble captivated the interest of the public as the seemingly “untouchable, unreachable” depths of space came into full view. This was shared and discussed on the blogs as the 2.0 Astronomers began “outreach astronomy”. This was seen to be vital to both the profession and the future of the now under pressure universities.

So who or what is the 3.0 Astronomer.

With the arrival of Facebook, Skype, social media and online meeting facilities like Webex and Google Plus hangouts, we now can put a telescope in the classroom, stream live video of the moon, the transit of Venus, the Curiosity landing on Mars, and host live star parties with a telescope in a video chat room. This clearly demonstrates what every advertising executive fears – the eyeballs will go to their “community of interest” first and foremost.

The AAVSO of course leads the way with its photometry-as-a-service in the cloud application, VPHOT. A lot of people are talking about “cloud services”, but like John O’Sullivan, astronomers are already doing it!

The 3.0 Astronomer is someone who can leverage the crowd, gather interested people through social media, connect around a citizen science activity and produce scientific results from the left over torrents of data from missions like the Kepler Space Telescope.

Zooniverse and Cosmoquest are two excellent examples of vibrant young astronomers who travel the world, have fans, sign autographs, have a media presence, are doing real science, and are expanding the pipeline of future science majors at universities through effective outreach. They are no longer the lonely astronomer at the top of the mountain.

I should point out here that the 1.0 Astronomer is still a vital part of research astronomy and always will be, but the future 1.0 Astronomers are being gathered to connect with their passion by the modern day 3.0 Astronomers.

One aspect of this latest astronomy paradigm is remotely hosted telescope infrastructure. Why spend hours setting up, playing with cameras and filters and doing the low value tasks when you can remote host. iTelescope.net hosts my pride and joy, a 0.5m Planewave CDK with a Fingerlakes CCD and 12-position filter wheel, at a dark sky site. Even if I work really hard I can only use it about 10-20 hours a month, the other 70 hours per month gets used by scientists and amateurs all over the world, including other AAVSO users and iTelescope.net members.

The highlight of my year was to recently walk into a year 7 science class at my kid's school. We'd had an

observing night which they loved and they were interested in doing more. An AAVSO alert early that morning had called for urgent data to support the Hubble Cosmic Origins Spectrograph observations that night. A CV which was supposed to be at magnitude 18 had bounced up to 17.5 and they wanted more data. The looks on the kids faces when I told them that their 7 data points were going to be used in a go/no-go decision on the Hubble Space Telescope was priceless!

Core to Context

 iTelescope.net Helps observatories move low value tasks from core to context

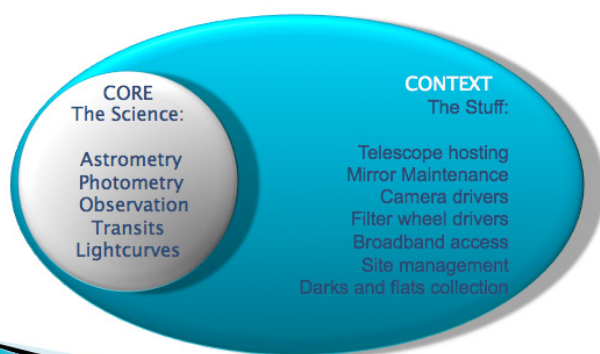


Fig 2. Moving the low value tasks from Core to Context

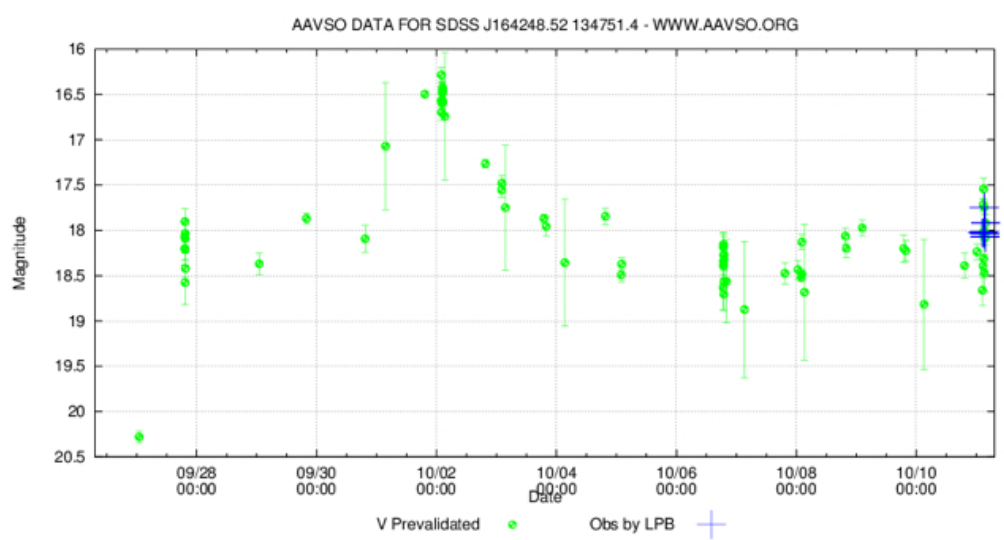


Fig 3. Data collected (under supervision) by Year 7 students for the AAVSO Alert

That's 3.0 Astronomy at its best!

Action Items

You can be a 3.0 Astronomer, if you have a relationship with a local school; the Year 9 coordinators are looking for curriculum enrichment opportunities, and welcome people coming in for class incursions, to support the classroom teacher as a subject matter expert. Variable star astronomy is within reach of the capability of any high school student with appropriate mentoring. If the school is tech-capable there is no reason why this can't be done via an online classroom with appropriate teacher supervision. I started by taking a little 4.5 inch reflector and getting the kids to assemble it in class whilst they were doing a space unit on telescopes and the difference between reflectors and refractors. We then had an observing night and their parents came along for the last half hour. Most schools have at least one science teacher who is passionate about astronomy and will be happy to have some parent helper/subject matter expert assist them.

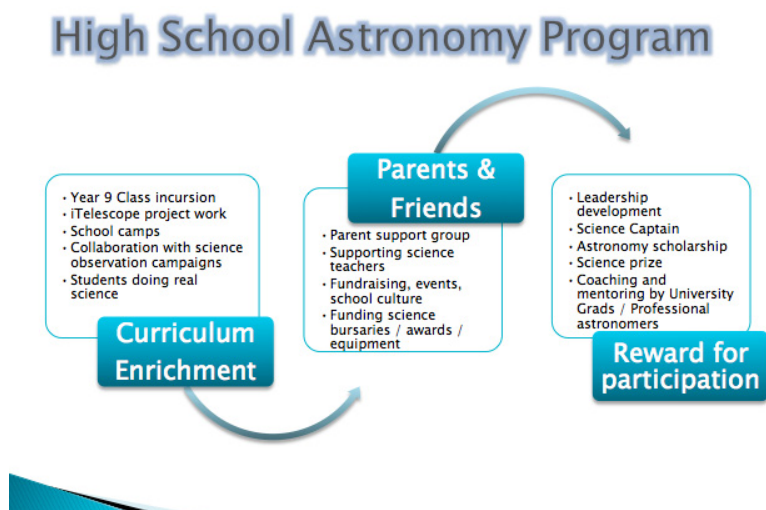


Fig 4. Developing an astronomy programme for high schools – What it might look like.

Join Cosmoquest.org and participate in real citizen science and education projects, like Vesta Mapper, Moon Mapper and Mercury Mapper, where you measure the size of craters and identify interesting features. Get your kids/grandkids involved and interested in science, you'll be amazed at their curiosity.

Zooniverse.org has over 500,000 members doing a range of citizen science projects. The original project Galaxy Zoo was a breakthrough project, and now you can participate in biology projects and cancer research.

iTelescope.net is an online community of amateur astronomers who share and use telescopes for as little as \$40 - \$100 per hour. The telescopes are high-end research grade scopes with a broader array of equipment than you could possibly put on on just one telescope. The full range of photometric and narrowband filters are available. Affiliates host their scopes and members can gain access through a membership account. iTelescope.net are just provisioning six new telescopes at Siding Spring in a new relationship with the ANU's Research School of Astronomy and Astrophysics. iTelescope.net will also provide grants to serious research projects.

The AAVSO can also make available telescope time for research projects.

Please feel free to contact me if you would like to ask any questions, need any help, or want to kick around some ideas.

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Selected SPADES Results – TU CMa, DO Car and BE Cru

Tom Richards, Co-leader, SPADES Project

The SPADES team has been gathering and analysing eclipse data on EA (Algol-type) eclipsing binaries for two years now, and an impressive record of results is accruing. The great bulk of the observational data has been obtained by Margaret Streamer (near Canberra) and David Moriarty (Brisbane); who have kept quite a large team of analysts very busy. All their work and the analyses can be found online on our website; follow Research Projects > SPADES > SPADES Observations. In addition minima and light elements are added to the VSS Eclipsing Binary Database at Info & Resources > Eclipsing Binaries & VSS > VSS Eclipsing Binary Database.

The primary aim of SPADES is to detect circumbinary planets by detecting cyclic variations in eclipse times of minimum (ToM) using the O-C method. Assuming a constant period, some Observed eclipses should arrive a little before the Calculated time, and some a little after, in a cyclic manner as the circumbinary planet repeatedly “pushes” the binary pair towards and away from us. This so-called light-time effect is readily observable, particularly for a massive planet in a distant orbit – a situation not easily detectable by other planet-finding techniques.

Thus in SPADES we concentrate on taking dense time-series CCD images of eclipses and measuring their ToMs, ideally to an accuracy of a few seconds. Those ToMs can then be used to look for that cyclic variation; but of course if a planet is in a ten-year orbit, it would take ten years to obtain one cycle. This is not a quick-fame project! Fortunately there is much else of astrophysical value we can do with that data.

Historical ToM data would help the project along quite a bit. Most bright EAs in the Southern Hemisphere were discovered in the 1920s to 1950s by photometric analysis of series of photographic plates. You’d think then that there are plenty of years from then till now for observers to obtain plenty of ToM data. Not so. The bulk of targets in SPADES have had no observational studies since discovery (though the ASAS-3 patrol does provide useful photometric data). Too many stars, too few astronomers! Where historic ToM data is available it’s usually visual or sometimes photographic, so too poor to use for a study like this one. More recently, some CCD measures do appear in the literature – a light shining in the darkness – but they are too few to help much.

So while we must make the best use we can of what historical data there is, it has to be said that by and large SPADES is covering new territory in the exploration of bright southern EA binaries. (Bright means down to about mag 14 or 15 – accessible with a CCD camera on a small (0.3-0.5 metre) telescope with exposures of a minute more or less. This does mean that our work cannot be confined just to looking for circumbinary planets – we need to study these neglected binaries themselves.

In the rest of this article I review work on three target systems for which I’m the analyst. You’ll see that the observational and analytical work tells three different stories – and that’s long before we start producing any astrophysical or planetary data.

In the following, light elements, which define the periodicity of eclipses are presented as the Heliocentric Julian Date of a selected minimum, called Epoch 0, and the orbital period P in days – which if multiplied by an integer E will predict the HJD of the E’t h eclipse after E0. Uncertainties are shown as digits in parentheses after a number, indicating the uncertainty in the least significant digits in that number.

TU CMa

06 31 36.72, -24 09 50.5 (J2000). Mag 9.7-10.7 V

This system has had some attention paid to it over the years since its discovery by Hoffmeister (1930). The original light elements are:

$$\text{HJD}_E = 2426977.445 + 1.1278041 \times E$$

The ASAS-3 light curve in Figure 1 (Pojmanski, 2002) shows a well-detached pair with partial eclipses and no sign of eccentricity.

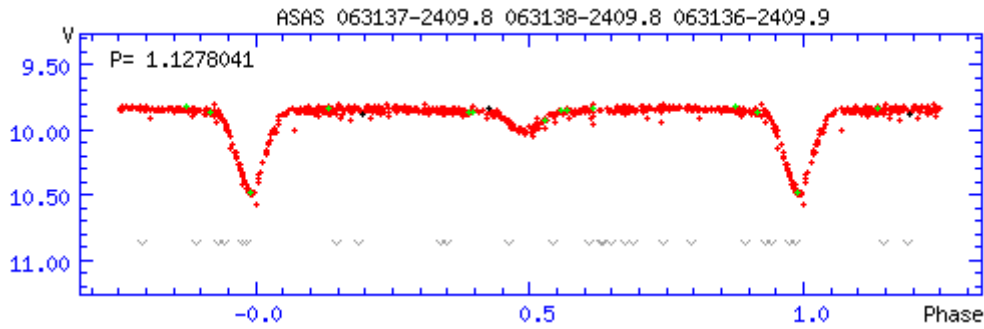


Figure 1. ASAS-3 folded light curve for TU CMA.

Margaret Streamer observed three primary eclipses in the 2011 and 2012 seasons, from which we derived the following light elements by regression:

$$\text{HJD}_E = 2455883.0534(2) + 1.127805(1) \times E$$

This period is slightly longer than the GCVS one of 1.1278041 d (Kholopov et al 1985) but at this stage of investigation it must be assumed that the difference is merely due to measurement uncertainties.

Mallama (1980) reported no period change in a study of 8 minima culled from various sources from 1972 to 1978, from which he derived a period of 1.1278012(24) d. Bob Nelson (http://www.aavso.org/sites/default/files/nelson.omc/2012/CMa_TU.xls) has collected 21 BBSAG data points, all visual, and two data points from the IBVS to derive elements

$$\text{HJD}_E = 2454070.67536 + 1.127804 \times E$$

There is no indication of a quadratic term, hence of period change. This period agrees with the SPADES period (above).

Conclusion: It's likely that there is no long-term period change, but since almost all existing data is visual, history offers no guide to the possibility of cyclic variations on sub-decadal timescales. More observations of minima in the coming season and beyond should be made to search for cyclic variations.

DO Car

10 13 20.58 -59 13 07.9 (J2000), Mag 8.9-9.3 V

When Ejnar Hertzsprung discovered this variable in 1924 (Hertzsprung 1924) he reported a period of 3.8543 d, after measuring 344 photographic plates. Glen Schrader's analysis of ASAS-3 data (personal communication) gives a considerably shorter period of 3.85199 d, close to the ASAS-3 figure of 3.85194 d (Figure 2).

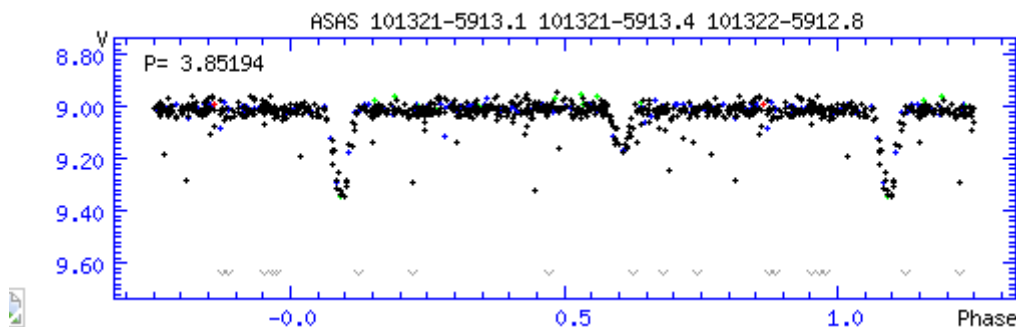


Figure 2. ASAS-3 light curve for DO Car, folded on $P=3.85194$ d.

Sergei Gaposchkin (1953) reported the same period of 3.85194 d after analysing 483 plates taken between 1938 and 1947. Otherwise, there appears to be no observational data.

David Moriarty obtained two eclipses of this system in 2011 and 2012. These show that the GCVS light elements, though very old, predict current eclipses successfully, with O-C values of 4 minutes or so.

That suggests a period change since discovery is unlikely. Looking more closely at the historical data, Hertzsprung, Gaposchkin and ASAS-3 all have a similar methodology of obtaining spot photometric

readings at well-separated times, usually several nights apart, rather than a time-series of observations that capture single eclipses. With enough observations, the spot-reading method can yield a good period, but deriving the exact time of minimum of even one eclipse is much less precise. Moreover photographic photometry in itself is very imprecise. However to investigate period changes, it's the times of minimum that we want. Finding the best average period that fits many years of data smooths over any small variations in period over that time. The most one can hope for is to find differences in such mean periods in widely separated eras. We do not find that.

The table below suggests the period has been constant for the last 70 years, but without uncertainty measures from the earlier data we cannot be sure if Hertzprung's data is consistent with Gaposchkin's. A PERANSO (www.peranso.com) analysis of the ASAS-3 data using Phase Dispersion Minimization gives $P = 3.8519(4)$ d (see Figure 3), not consistent with Hertzprung's period. The experience of many eclipsing binary researchers agrees that light elements derived from photographic measures, as well as visual, have very low reliability. So, we discount Hertzprung's period as showing period change, and can only say it hasn't changed much if at all on decadal timescales.

Source	Era	Period
Hertzprung	<1924	3.8543
Gaposchkin	1938-1947	3.85194
ASAS-3	2001-2009	3.85194
SPADES	2011-?	More times of minimum needed.

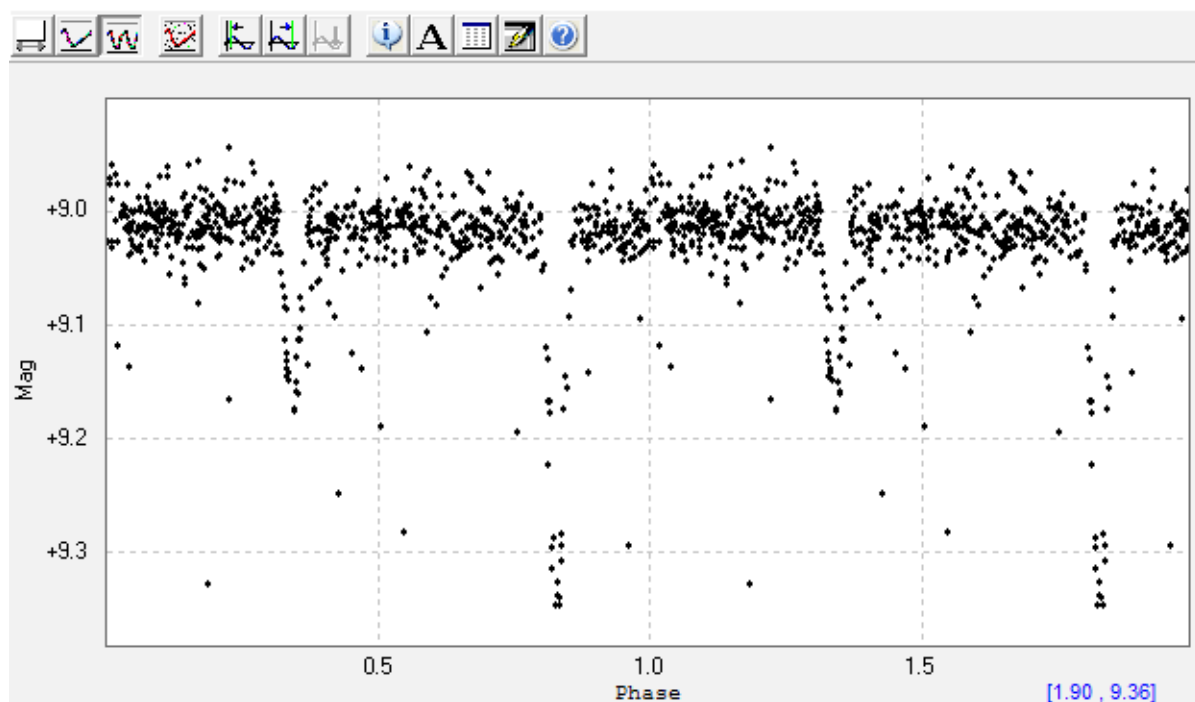


Figure 3. ASAS-3 A and B quality data on DO Car, folded on a period of 3.8519 d derived in PERANSO. The light curve is of poor quality, but typical of ASAS-3 data.

Conclusion: The ASAS-3 period is accurate and there appears to be no period change, but SPADES needs to obtain many accurate minima over the next few years, to look for period variations on shorter timescales.

BE Cru

12 27 33.20 -58 16 19.3, Mag 12.7-13.5 (V)

David Moriarty obtained three beautiful eclipses of this system in 2012; the latest is in Figure 4.

The three eclipse measurements yielded these light elements:

$$\text{HJD}_E = 2456084.0375(4) + 2.22103(6) \times E$$

The GCVS period (obtained in 1927) is 2.220947 d, outside the error of the SPADES period. Aside for a single visual measurement of minimum in the intervening 85 years, there has been no observational work on this system.

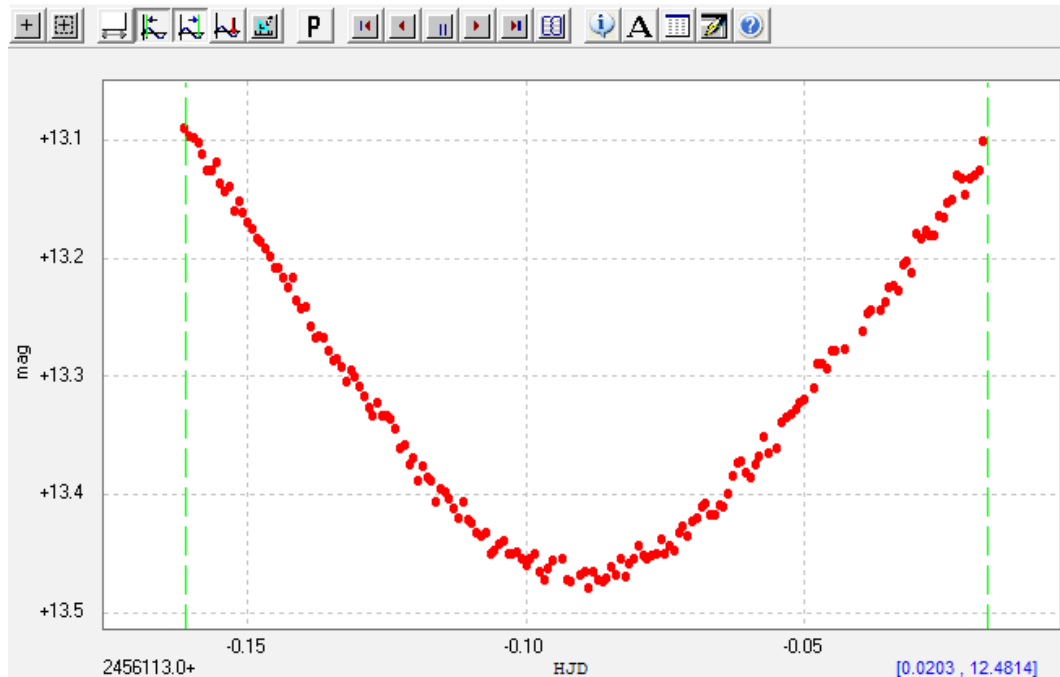


Figure 4. Eclipse of BE Cru obtained by David Moriarty on 2012-07-04.

The ASAS-3 light curve on this system is interesting (Figure 5). At magnitude 13+ this data is at the faint end of the ASAS-3 instruments' capability, hence the noise. Folding their data on the GCVS period yields a light curve with only one minimum (unless you have a lot of imagination!)

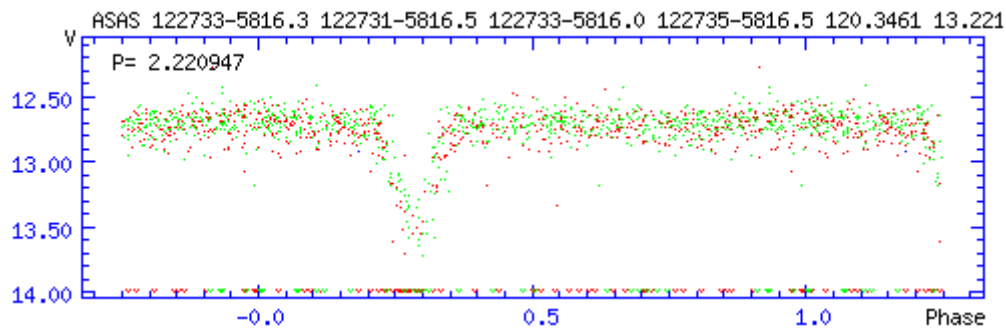


Figure 5. The ASAS-3 data on BE Cru, folded on the GCVS period of 2.220947 d.

If the orbit is circular, as EAs nearly always are, there must be two eclipses. Then could the true period be double this, and the Figure 5 light curve is superimposing the two eclipses? See Figure 6.

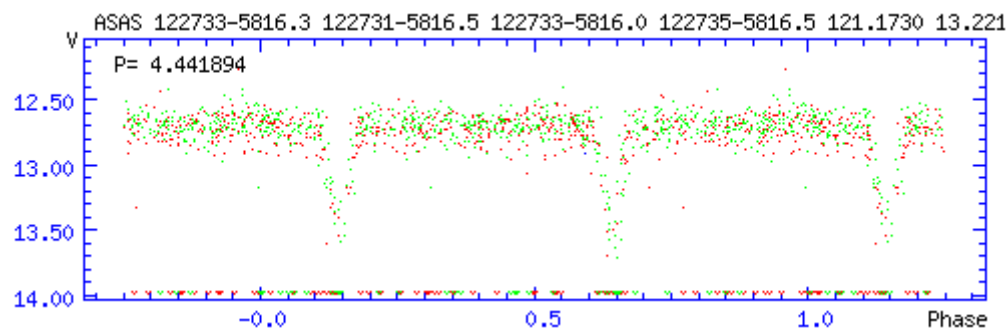


Figure 6. ASAS-3 data on BE Cru, folded on 4.111894 d, double the GCVS period.

The double-period light curve is inconclusive as it is not sorting out a shallower secondary from a deeper primary – the two eclipses look about the same depth. So the “P/2P problem” is not resolved. Either the orbit is elliptical with the shorter period, and the line of apsides is pointing in our direction and the smaller star misses eclipse at apoastron; or we have two very similar stars yielding similar depths of eclipse. Without radial velocity data the only ways to sort out this dilemma are (i) by careful observing of odd- and even-numbered eclipses (assuming the shorter period) to see if they differ in depth, and (ii) to look for signs of a secondary eclipse (again assuming the shorter period).

Moriarty obtained two even-numbered eclipses and one odd. They do not differ in depth. Fortunately, we have an indication of a secondary minimum. An earlier run of Moriarty’s on 2011-06-19 shows the beginning of an eclipse. A secondary was predicted on the SPADES light elements (above) to occur at JD 2455732.004476, less than an hour and a half after he stopped observing. See Figure 7. This makes the shorter period very likely correct, and the shallow secondary minimum is simply lost in the noise in the ASAS-3 data.

Conclusion: The first thing we need to do is to confirm that secondary eclipse. With no useful data since discovery, we cannot investigate historical period change. So future work is to obtain numerous times of minimum, primary and secondary, over the coming years, to look for period change or cyclic variations. The SPADES campaign on this star is essentially starting from scratch.

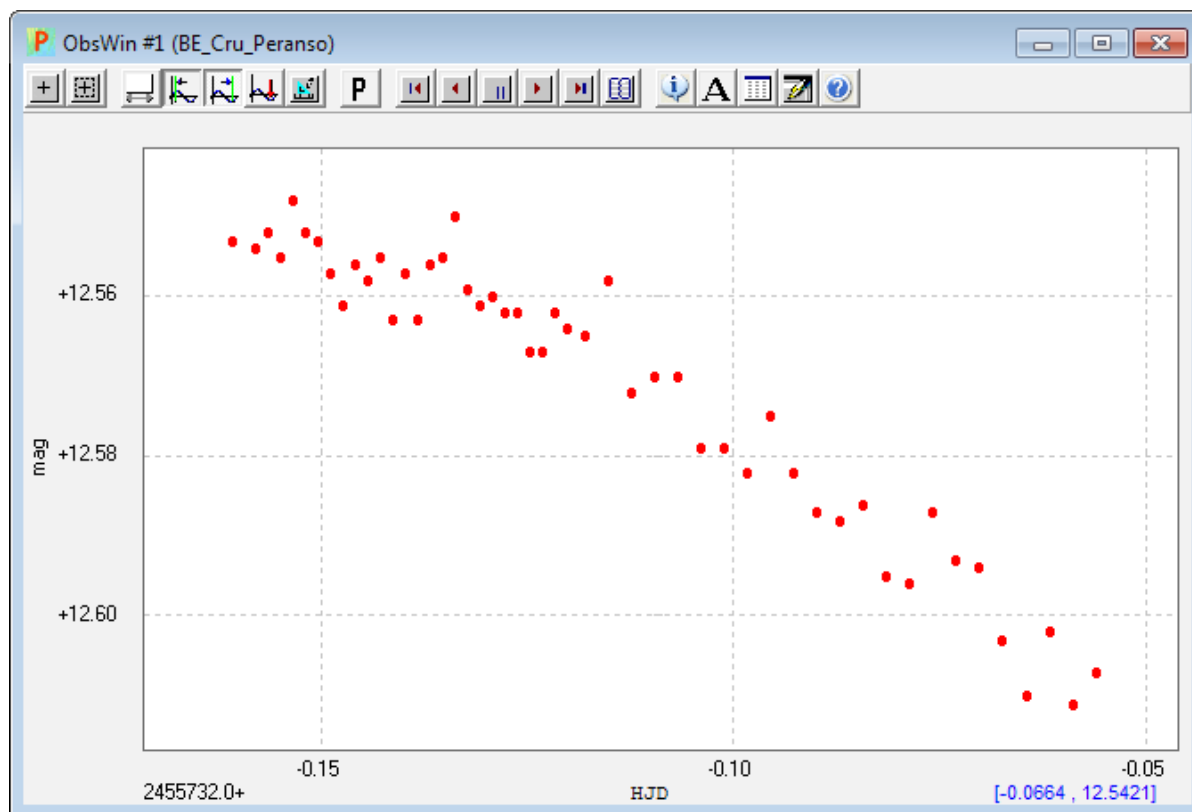


Figure 7. A presumed descent to a secondary minimum, recorded by Moriarty on 2011-06-19.

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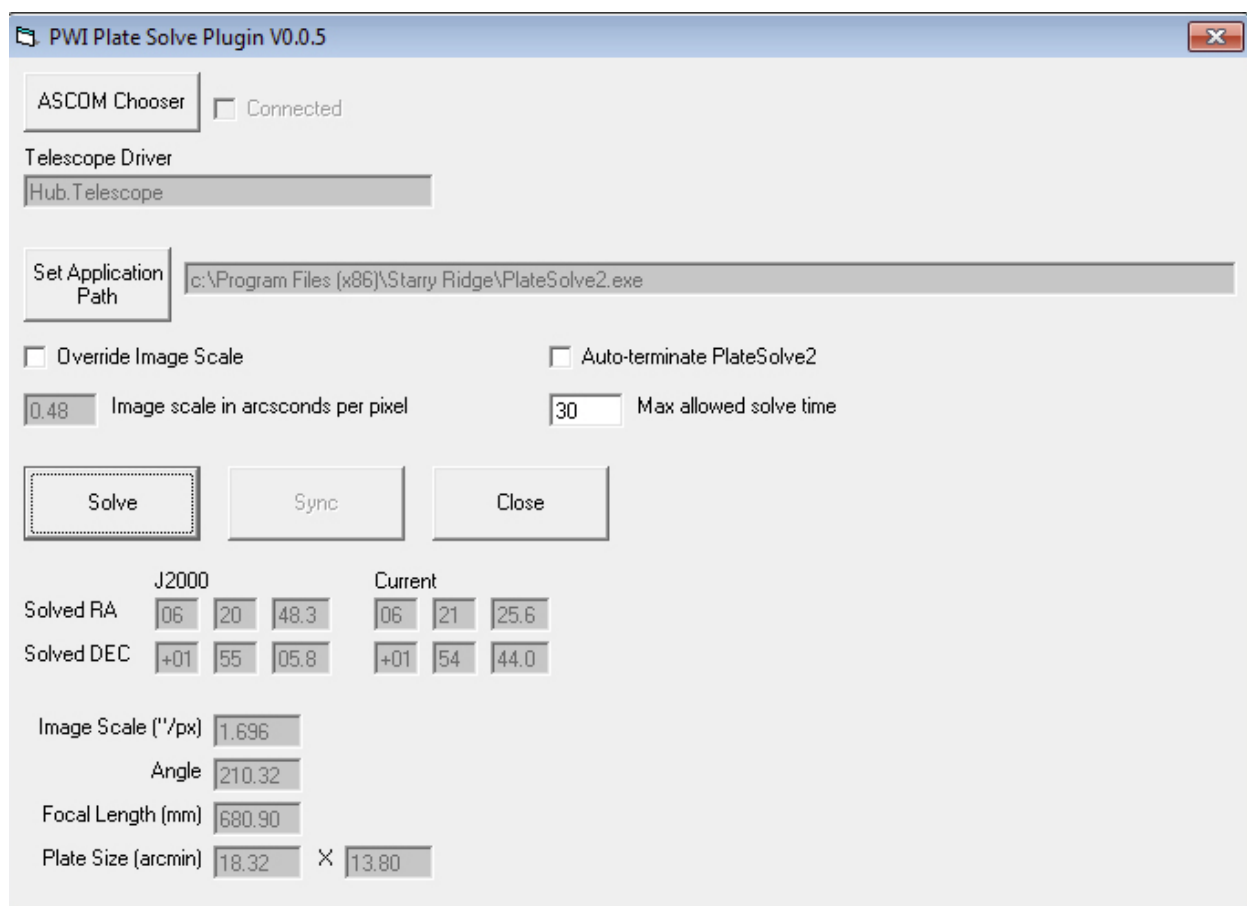
Software Watch - *Phil Evans*

David Motl has released a stable version 2 of his photometry package **Muniwin**. The latest version is 2.0.6 and is available from <http://sourceforge.net/projects/c-munipack/files/latest/download?source=files>

In version 2 a data set becomes a project and each project has its own folder which hold the temporary files and configuration files allowing the user to switch easily between projects without having to delete all the frames of an existing set.

The existing modus operandi remains and users will find it just as easy to use as version 1.2. There are some minor improvements in graphs and individual items can now be removed from the mag - dev curve along with a couple of bug fixes.

PlateSolve2 is a free application developed by Dave Rowe at Planewave Instruments for plate solving of astronomical images. A plugin version for MaximDL has been developed by Andre at Astrogeeks.com who says it is faster and more robust than Pinpoint LE which is included with Maxim.



I haven't tried so cannot verify this claim.

The plugin is available from http://astrogeeks.com/AstroGeeks/andre/ps2_plugin/

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.VariableStarsSouth.org> and its e-group <https://groups.google.com/forum/?fromgroups#!forum/variablestarssouth>. It also encourages members to work in with major international organisations such as the British Astronomical Association, the Center for Backyard Astrophysics and the American Association for Variable Star Observers.

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

WHO’S WHO

Director Dr Tom Richards, FRAS.

Treasurer/Membership Bob Evans

Newsletter Editor Phil Evans

Webmaster David O’Driscoll

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

MEMBERSHIP

We invite all who are interested in southern variable star research to join VSS. Your membership fees support the organisation’s overheads and support the VSS Research Grants Scheme. The joining fee is NZ\$30.00 and thereafter the annual membership renewal, due on 30 April, is NZ\$20.00. Members and non-members alike can take part in VSS projects, join the VariableStarsSouth forum on Google Groups, and make use of our website’s online specialist forums (to contribute to a forum, register through the “User Login/Logout” link on the home page). Financial members are eligible for research grants, see Community > Research Grants on our website.

NEWSLETTER ITEMS

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 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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