British Astronomical Association

VARIABLE STAR SECTION CIRCULAR

No 169, September 2016

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SPECTRUM OF SN2016FNR DISCOVERED BY RON ARBOUR

ROBIN LEADBEATER

Figure 1

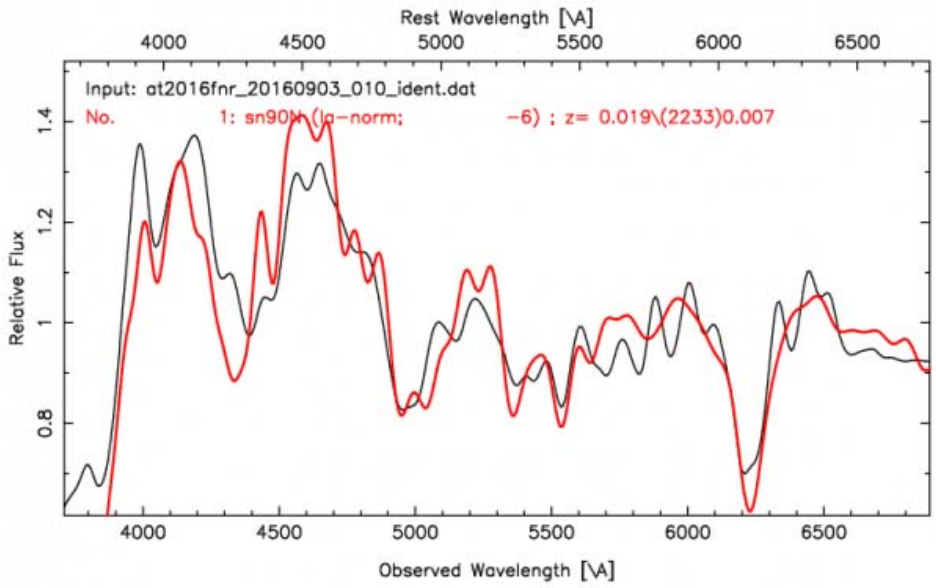

Figure 2

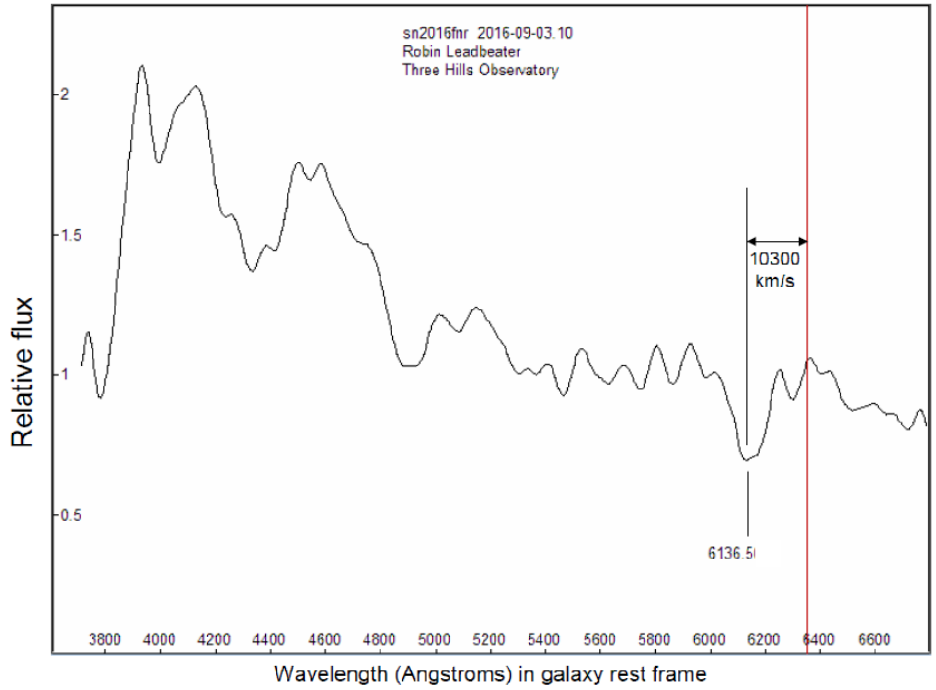

Figure 1:
Unfortunately I was clouded out in the days following the discovery by Ron Arbour of sn2016fnr on 29th August < *https://wis-tns.weizmann.ac.il/object/2016fnr* > and the type (Ia) had already been confirmed before I was able to take a spectrum last night.
My spectrum taken at ~ mag 16 using the modified ALPY "200" however confirms with high confidence the classification of a type Ia supernova near maximum light as assessed using the supernova identification program SNID < *https://people.lam.fr/blondin.stephane/software/snid/* >
The attached shows my spectrum (black) overlaid on the best fit spectrum from the SNID library.

Figure 2:
Supernova sn2016fr was discovered in UGC1050 at mag 16.4 by Ron Arbour on 29-8-2016. This spectrum recorded by Robin Leadbeater 4 days later shows the characteristics of a young type Ia supernova. The velocity of the ejecta as measured in the blue shifted Si II 6355 line is estimated at 10300 km/s.

FROM THE DIRECTOR ---- ROGER PICKARD

Spectroscopy
Further to the Ridley Grant applications I mentioned in the last Circular, I can now advise that they have been awarded to eight applicants for assistance with purchasing Alpy 600 spectrographs.

There will be a further spectroscopy workshop on 28th-30th October at Kintbury, Berkshire, about setting up and using the equipment and analysing spectroscopic data. There will be limited places available, but it may just be worth contacting David Boyd <*davidboyd@orion.me.uk*> if you are interested in attending, to see if there are any places still available.

Director
By the time you read this Circular, I note that I shall have completed 17 years as your Director, as I took over from Gary Poyner at the end of August 1999! It does not seem that long ago.

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TONY MARKHAM'S FINAL VARIABLE STAR OBSERVATION ---- TRACIE HEYWOOD

I do not keep an up to date count as to how many variable star observations I have made, but in early June this year I did check my overall total and found that I had passed the 150K landmark.

It is tricky to say exactly which was my 150,000th observation as I tend to observe several stars in a row and then write down the observations all together, but not necessarily in sequential order. Working backwards, I worked out that my 150,000th would have been one of several stars for which I logged the time as 02:40 UT on the morning of May 1st. Randomly picking one of these stars, I nominate my 150,000th observation to have been:

2016 May 01 0240 UT V Boo = H+1 mag 8.0 class 1 sequence 037.02
... but that's not the biggest news ...
The biggest news is that Tony Markham made his final variable star observation (of Beta Pegasi) on June 30th, taking his final total to 150,941.

That was Tony's final observation because, as of July 1st, I've changed my name via deed poll to: Ms Tracie Louise Heywood.

I also have a new email address (see below) and a new Facebook account:
http://facebook.com/tracie832

You can probably guess what else I have planned for the future, but it is a long process that will take years. I will be posting updates via my new Facebook account.

As of the end of July, Tracie had 401 observations in the database.

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REPORT ON THE 35TH SYMPOSIUM OF THE SOCIETY FOR ASTRONOMICAL SCIENCES, JUNE 2016

DAVID BOYD

The Society for Astronomical Sciences is an organisation based in the US, but with an international membership, which holds an annual symposium bringing together amateur astronomers engaged in small-telescope scientific research and professional astronomers. For several years now the symposium has been held at the Ontario Airport Hotel in Ontario, California. Previously it was held at Big Bear Lake close to the location of the Riverside Telescope Makers Conference.

This year's event, the 35th in the series, was held from 16th to 18th June, and followed the normal schedule of a day of workshops followed by two days of paper sessions, with lunchtime discussion meetings on various topics and after dinner talks from professional astronomers. The workshops this year were on the theme of spectroscopy with a general introduction to the subject by Dale Mais and John Menke in the morning, followed after lunch with a session on the theme of "What publishable science can we do with spectrographs on small telescopes?". The speakers were Russ Genet, Gary Cole, Stella Kafka, the new AAVSO Director, and Richard Gray, co-author of the definitive textbook Stellar Spectral Classification.

At a lunchtime discussion meeting on spectroscopy, Stella Kafka outlined the AAVSO's plans to set up a spectroscopic database and opened a discussion about the format they should adopt for such data. A small working group was then formed, including myself, in which Stella and I argued strongly that the AAVSO should adopt essentially the same FITS-based format as has been used for several years by the BeSS consortium in Europe. Stella herself is Greek and brings an interesting mid-Atlantic perspective to the debate which helped to steer us towards building on previous experience rather than reinventing from scratch.

The papers presented during the symposium covered a wide range of topics including

Group photograph of SAS 2016 symposium participants. (credit Earl Wilson)

spectropolarimetry, amateur exoplanet research, binary system analysis, photometric data reduction, light pollution surveys and many others. I gave a talk on my measurements of stellar radial velocities using a LISA spectrograph, in which I showed that with careful observational technique it is possible to greatly exceed the theoretical capability of such a low resolution device. I also presented posters on the BAA's initiative to support the purchase of Alpy spectrographs and my photometric and spectroscopic observations of the recent outburst of the symbiotic star AG Draconis. Video recordings were made of all the talks and in due course these will appear along with the papers on the SAS website at:

http://www.socastrosci.org/

There were around 100 participants in the symposium this year and as far as I am aware I was the only one who had travelled from Europe. Occasionally the event is a joint one with the AAVSO and/or the Center for Backyard Astrophysics (CBA) which raises the attendance to well over 100. The event is sponsored by a number of the leading suppliers to the amateur market and they have trade stands in the room adjacent to the lecture theatre. Inspection of the group photograph will reveal that participants tend to be of an age where they have the leisure time and finances to indulge their astronomical interests and there is still a large imbalance between the numbers of men and women.

I find the event a good opportunity to meet people you only know by email, and to find out where the leading edges are in amateur astronomy. I was surprised this year not to see more work being done in spectroscopy in the USA, in spite of the high profile the subject had in the symposium programme. I think this will gradually change with new management at the AAVSO, but it will take a few years before it catches up with the volume and quality of work being done in Europe.

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THE ONSET OF THE SUPER-ACTIVE STATE OF T CORONA BOREALIS IN 2015

JOHN TOONE

T CrB is the brightest known recurrent nova, with major outbursts peaking at magnitude 2 in 1866, and magnitude 3 in 1946. The T CrB system consists of an M3III giant in a 227.57 day orbit around an active white dwarf. Outside of major outbursts the light curve is dominated by ellipsoidal variations (first reported by Bailey from BAA VSS visual data) caused by the orbital motion of the tidally distorted red giant. The ellipsoidal variation produces two maxima and two minima within each orbit. Superimposed on the ellipsoidal variations are actions associated with the white dwarf, which causes spells of erratic activity, in addition to high state activity seen in 1981-1986 and 1996-1999, and super-active state activity in 1938 and 2015 (both intriguingly 70 years after the major outbursts of 1866 and 1946).

The super-active state of T CrB in 2015 has been described by Munari et al in arXiv.1602.07470. The AAVSO reported (Special Alert Notice 415) that T CrB was V=10.2-10.3 up to early February 2015 then the mean brightness increased to V=10.0 until February 2016 when it further brightened to V=9.2.

In the 35 year period between May 1981 and April 2016 I have secured visual observations of T CrB on 2985 nights and can provide more detailed information on the lead up to the 2015 super-active state. The light curve for the years 2010 to 2016 is reproduced as Figure 1, and is derived from 755 observations on 754 nights up to the end of April 2016. The outline variations seen in the years 2010 to 2014 are summarised in Table 1.

Table 1 – Outline variations of T CrB in 2010-2014

Year	Mag Range	Form of Variation	White Dwarf Activity
2010	10.3-10.9mv	Ellipsoidal	No
2011	10.3-10.9mv	Ellipsoidal	No
2012	10.2-10.7mv	Ellipsoidal/Erratic	Yes (latter part)
2013	10.3-10.7mv	Erratic/Ellipsoidal	Yes (first half)
2014	10.3-10.8mv	Ellipsoidal	No

From late-2012 to mid-2013 the ellipsoidal variations were replaced by erratic behaviour which was assumed to be caused by activity associated with the white dwarf. Following this spell of erratic behaviour the ellipsoidal variations returned but with a reduced range. At the very start of 2015 there was an ellipsoidal maximum at 10.2mv which was 0.1 magnitude brighter than those seen in 2010-2011. Then there was a well-defined ellipsoidal minimum around 5 March 2015 at 10.6mv which was 0.1 magnitude brighter than those previously recorded since 2010. By the end of March 2015 the star had brightened to 10.2mv which is the level I expected it to peak at for an ellipsoidal maximum. Then came April 2015, a month where I secured observations of T CrB on 21 nights (a particularly

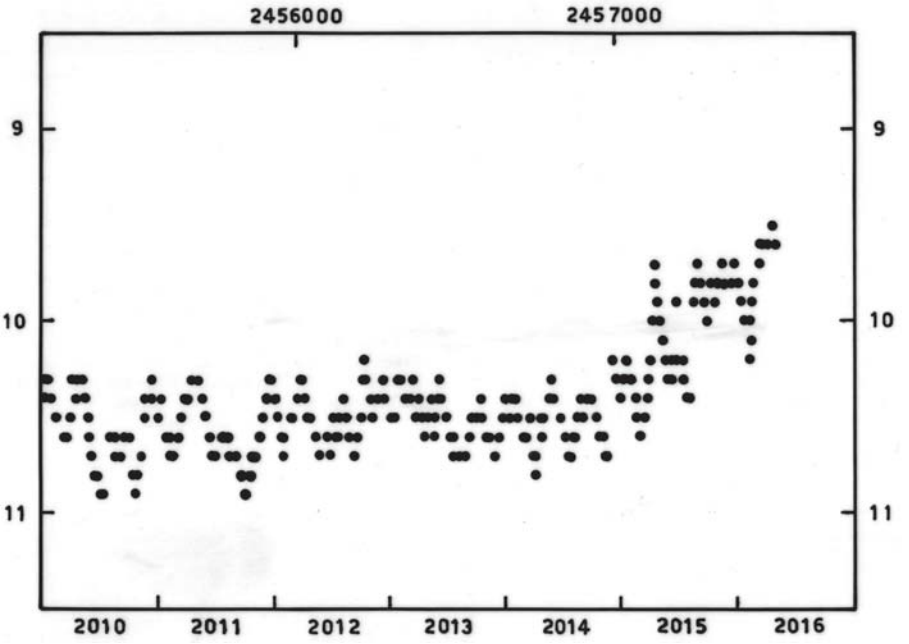

Figure 1: Light curve of T CrB during 2010-2016 compiled from 755 visual observations.

good month weather-wise) and those for the first half of the month are reproduced in Table 2.

Table 2 – Visual observations of T CrB in the first half of April 2015

Date	Time (GMT)	Estimate	Mag (mv)	Class	Instrument
1 April 2015	04:22	L(3)V(2)M	10.2	1	20cm SCT
4 April 2015	21:52	L(3)V(2)M	10.2	1	20cm SCT
5 April 2015	22:58	L(1)V(2)M	10.0	1	20cm SCT
6 April 2015	20:48	=L	9.8	1	20cm SCT
6 April 2015	23:02	=L	9.8	1	20cm SCT
7 April 2015	21:04	=L	9.8	1	20cm SCT
8 April 2015	23:02	=L	9.8	1	20cm SCT
9 April 2015	21:20	L+1	9.7	1	20cm SCT
11 April 2015	23:03	=L	9.8	1	20cm SCT
12 April 2015	21:50	=L	9.8	1	20cm SCT
13 April 2015	22:20	=L	9.8	1	20cm SCT
14 April 2015	21.02	=L	9.8	1	20cm SCT

The 0.2 magnitude rise between the 4th and 5th April caught my attention, because I had to go back to 1999 (at the end of the last high state activity) to have previously recorded it at this high level of brightness. The following night (6th April) it had brightened a further 0.2 magnitude and I thought it might be going into full outburst. I then made a

further observation 2 hours later that indicated no change, so I refrained from sending out an alert message. I later learned that at this point in time, the normal 0.4 magnitude systematic difference between my visual data and the V data reported to the AAVSO International Database reduced to 0.2 magnitude. This was a strong indicator that the T CrB system had changed in colour towards the blue, providing further evidence of the timing of the onset of activity associated with the white dwarf.

T CrB levelled out at around 9.8mv in mid-April 2015 and then faded back to 10.0mv by the end of the month. The star would continue to vary at an elevated level between 9.7-10.4mv for the next year before rising up to 9.5mv in April 2016. As I write these words (August 2016) T CrB is at 9.7mv. The present brightness level has not been attained throughout the 35 years I have been monitoring it including the high state phases seen in 1981-1986 and 1996-1999.

In conclusion I can confirm that the super-active state of 2015 commenced in full in early April (4th to 6th) 2015 but earlier indications of impending activity can be traced back to the slightly enhanced ellipsoidal maximum around New Year's Day 2015, and the bright ellipsoidal minimum that followed in early March 2015. A further point for consideration is that the erratic behaviour, recorded in 2012-2013, may have been some kind of precursor to the super-active state that followed in 2015. The form of the light curve in Figure 1 hints at that possibility.

As an additional exercise I decided to check whether the ellipsoidal variations recorded in 2010-2015 aligned with the orbital period of 227.57 days. To do this I extracted the minima that could be clearly identified from the light curve in Figure 1 and listed them in Table 3:

Table 3 – Ellipsoidal minima of T CrB in 2010-2015

Date	JD	Mag (mv)
8 March 2010	2455264	10.7
28 June 2010	2455376	10.9
20 October 2010	2455490	10.9
15 February 2011	2455608	10.7
21 June 2011	2455734	10.7
1 October 2011	2455836	10.9
27 January 2012	2455954	10.7
27 May 2012	2456075	10.8
8 September 2012	2456179	10.8
10 August 2013	2456515	10.7
23 November 2013	2456620	10.7
30 March 2014	2456747	10.8
19 July 2014	2456858	10.7
14 November 2014	2456976	10.7
5 March 2015	2457087	10.6

The interval from 8 March 2010 to 5 March 2015 is 1823 days, and during this time there were 17 minima (2 were missed in 2012-2013 due to the erratic behaviour), so the average

period was 113.94 days. Since there are two minima within each orbit, the total period works out at 113.94 x 2 = 227.88 days. This provides clear evidence to confirm that the ellipsoidal variations in 2010 to 2015, leading up to the 2015 super-active state, were closely aligned with the orbital period.

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ECLIPSING BINARY NEWS - AUGUST 2016

DES LOUGHNEY

RW Tauri

This used to be a classic, well observed, system. It was famed for the rapid decrease in magnitude during the primary eclipse. The latter sees a drop from about magnitude 8 to about magnitude 11.5, with a fast drop of 1 magnitude in a quarter of an hour. According to the Krakow web site, the period is changing relatively quickly so that an up to date determination of the time of primary minimum would be worthwhile. The data on the BAVSS website shows that a primary minimum has not been determined by our observers since 2004.

The period used in making the predictions, published monthly on our website, is 2.7687546 days. The Krakow web site states that the current period is 2.768783 days. This represents a difference of 2 seconds which may not seem very much. However, it suggests that our predictions may have been out by over 2 hours compared with the Krakow predictions. The chart that is available on the BAAVSS website was prepared in 1984 (T Brelstaff 1984 Dec 18). There is listed a preliminary sequence of 10 comparisons. The magnitudes of these comparisons differ from those listed in the Hipparcos and Tycho catalogues:

Comparison C is listed as 7.91 whereas HIP 19068 has a V magnitude of 7.94.

Comparison D is listed as 8.2 whereas TYC 1826-1258-1 has a V magnitude of 8.12.

Comparison E is listed as 8.9 whereas TYC 1822-2103-1 has a V magnitude of 8.45.

Comparison F is listed as 9.3 whereas HIP 18892 has a V magnitude of 8.82.

Comparison H is listed as 9.7 whereas TYC 1821-1830-1 has a V magnitude of 9.72.

Comparison J is listed as 10.0 whereas TYC 1826-145-1 has a V magnitude of 9.81.

Comparison M is listed as 10.5 whereas TYC 1821-1868-1 has a V magnitude of 11.19.

Comparison N is listed as 10.7 whereas TYC 1822-1765-1 has a V magnitude of 11.4.

Comparison P is listed as 11.1 whereas TYC 1822-1730-1 has a V magnitude of 11.66.

Comparison Q is listed as 11.6 whereas TYC 1822-1616-1 has a V magnitude of 11.70.

It is proposed to do a study of this system later this year to determine the time of primary minimum but also to confirm as far as possible the magnitudes of the comparisons.
Spectroscopists may be interested in the fact that, while the primary eclipse lasts 84 minutes, for 20 minutes after ingress, and before egress, the spectral lines of prominences of the primary can be observed.

Kepler Telescope and Eclipsing Binaries
Wikipedia introduces the Kepler Telescope as follows:

"Kepler is a space observatory launched by NASA to discover Earth-size planets orbiting other stars.[5][6] Named after astronomer Johannes Kepler,[7] the spacecraft was launched on March 7, 2009,[8] into an Earth-trailing heliocentric orbit.

Designed to survey a portion of our region of the Milky Way to discover Earth-size exoplanets in or near habitable zones and estimate how many of the billions of stars in the Milky Way have such planets,[5][9][10], Kepler's sole science instrument is a photometer that continually monitors the brightness of over 145,000 main sequence stars in a fixed field of view.[11] This data is transmitted to Earth, then analyzed to detect periodic dimming caused by exoplanets that cross in front of their host star."

Editor's Note: details of the References given in the above quotation from Wikipedia are not included in this article.

In addition to exoplanets, Kepler has been detecting eclipsing binaries. It was known before the Kepler mission that there were 383 EBs within its 105 square degrees field of view. However, Kepler had discovered an additional 1879 EBs by 2011, rising to 2876 by 2016. The EB papers arising from the Kepler observations are listed on:

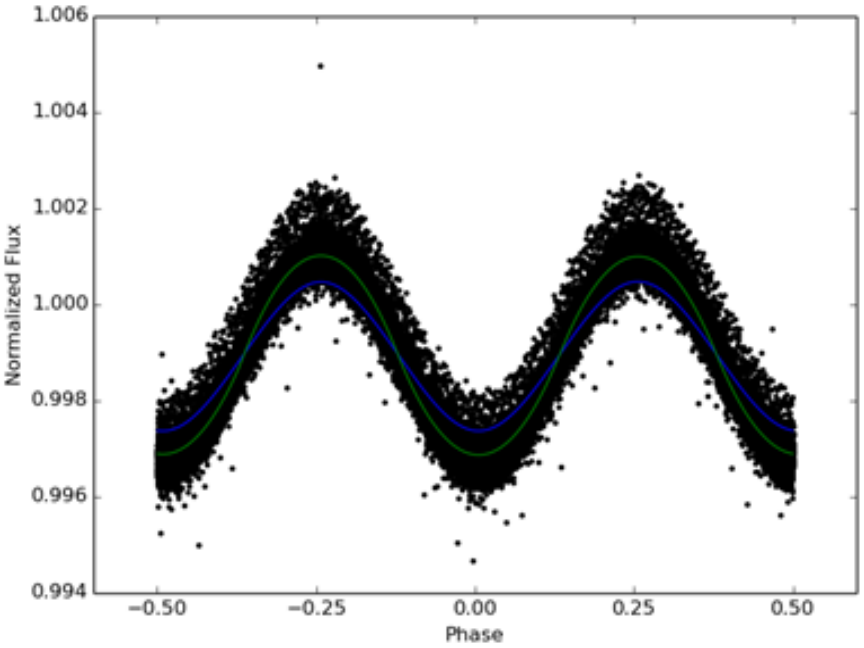
<http://keplerebs.villanova.edu/papers>

This web page can also be used to access the Kepler Eclipsing Binary Catalog (Third Revision). At the time of writing it was last updated on 9th August 2016 with 2876 entries.

The second EB on the Catalog list is KID 8912468 which has a period of 0.094838 days, a magnitude of around 11.75, and a primary eclipse depth of 0.0041 magnitude. This shows the sensitivity of the Kepler camera. In the catalogue there is a diagram of the system data for KID 8912468 which is shown in Figure 1.

The instrumentation and methodology can be studied in the paper by Andrea Prsa et al[1]. In this paper the purpose of the Catalog is described as serving " as a bridge between the now public Kepler data and the scientific community interested in eclipsing binary stars".
It may be a topic of discussion within the BAAVSS as to whether the amateur scientific community can do work with the database. Given the continous coverage for an extended period of the new EBs it might be useful to exame the data of a specific EB to see if there is any variation over time in the light curve including shape and depth of minima. Within the Kepler field of view there are 383 known eclipsing binaries. At the time of writing it is not known whether data has been collected on these stars, and whether the data is available to the public. It may be that Kepler was not designed to study stars fainter than magnitude 8 and, therefore, no data has been collected on those known EBs.

Figure 1: data for KID 8912468
from the Kepler Eclipsing Binary Catalog (Third Revision)



Reference

1) Andrea Prsa et al, "Kepler Eclipsing Binary Stars. I. Catalog and Principal Characterization of 1879 Eclipsing Binaries in the First Data Release", *The Astronomical Journal*, Volume **141**, Issue 3, article id. 83, 16 pp. (2011 March)

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LONG TERM TRENDS IN BINOCULAR VARIABLE LIGHT CURVES (PART 1)

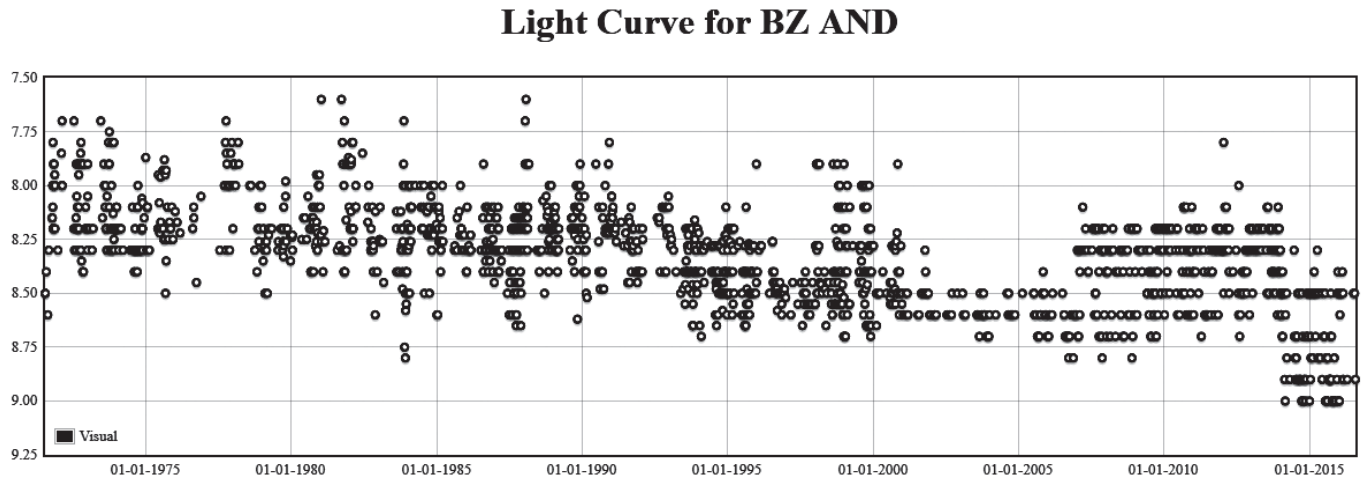
TRACIE HEYWOOD

Nowadays, there are various software tools that can be used to analyse a list of variable star estimates and look for possible periods. Sometimes, however, it can be interesting to just look at the light curve and look for long term periods and trends and to see how closely the star's behaviour has matched the range and periods quoted in the programme listing

Of course, we have to also remember that over the years there may have been factors not related to the star itself that impact the light curve. Not only will observers have come and gone but in some cases there will also have been changes to the comparison star sequence. The latter factor, if present, can lead to sudden jumps upwards or downwards in the light curve.

Given that the accompanying light curves cover the interval from 1971 to summer 2016, catalogued periods of just a few months in duration will not be visible. The magnitude ranges will also be exaggerated by differences between observers in red sensitivity. Here are a few examples:

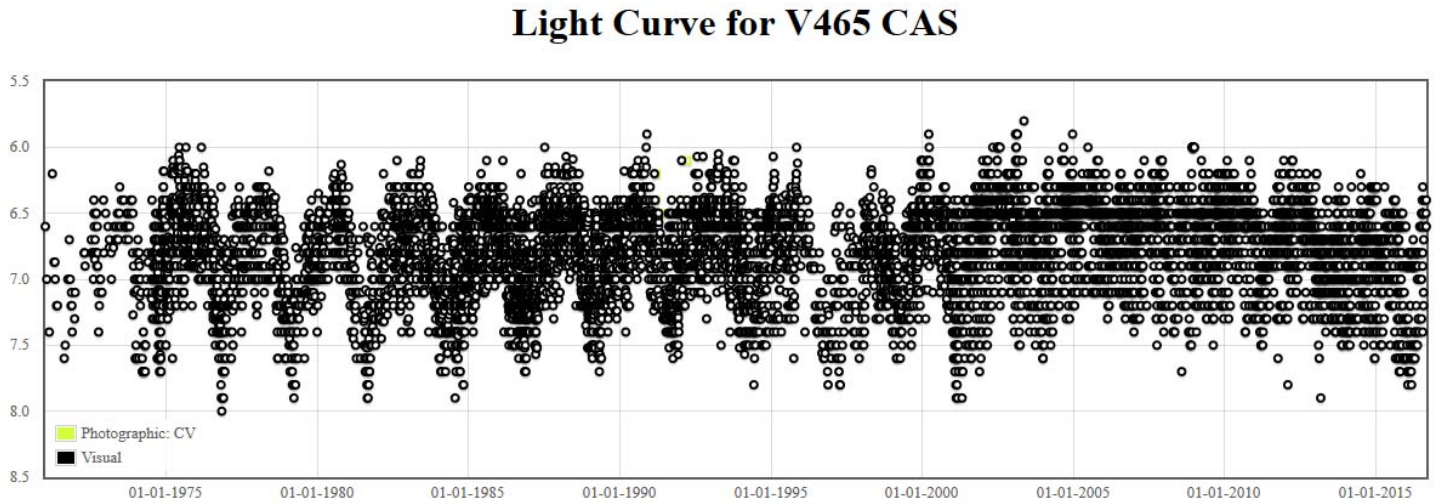
Figure 1: BZ And (Catalogued range 7.5-8.4, type Lb)



Symbol Key: **Crosses** = Negative observation, **Triangle** = Brighter than, Otherwise: **Circle** = Visual, **Diamond** = CCD, **Square** = Everything else

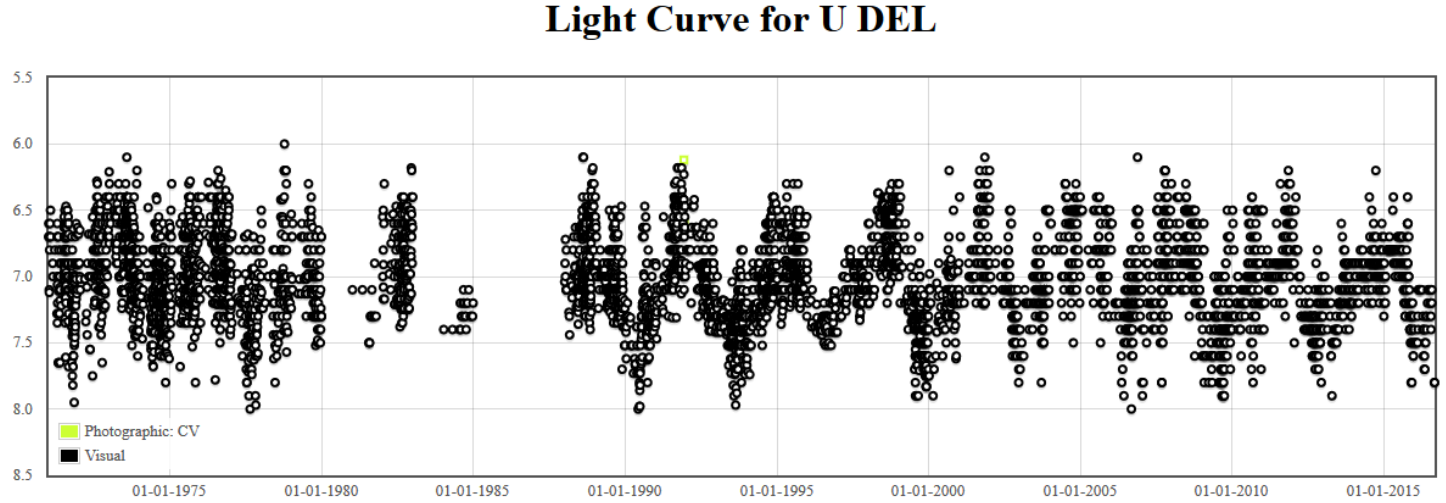
The main impression here is of a slow fade. Although the early observations of BZ And were largely within the listed magnitude range, those in more recent decades have better matched a range of 8.0-8.7. The recent dip of about 0.3 mag is most likely related to a sequence change.

Figure 2: V465 Cas (Catalogued range 6.2-7.8, type SRb, period 60 days)



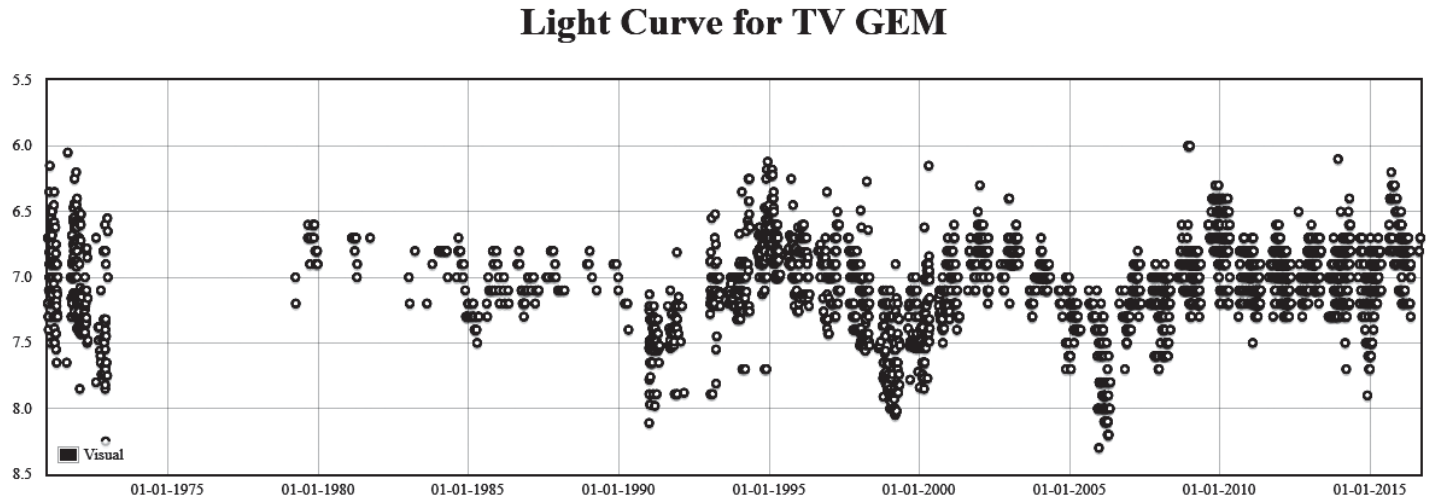
The magnitude range seen for V465 Cas seems to match quite well the catalogued range. There is good evidence, especially in the earlier years, for a longer term period of about 2 years.

Figure 3: U Del (Catalogued range 5.6-7.9, type SRb, period 110 days?)



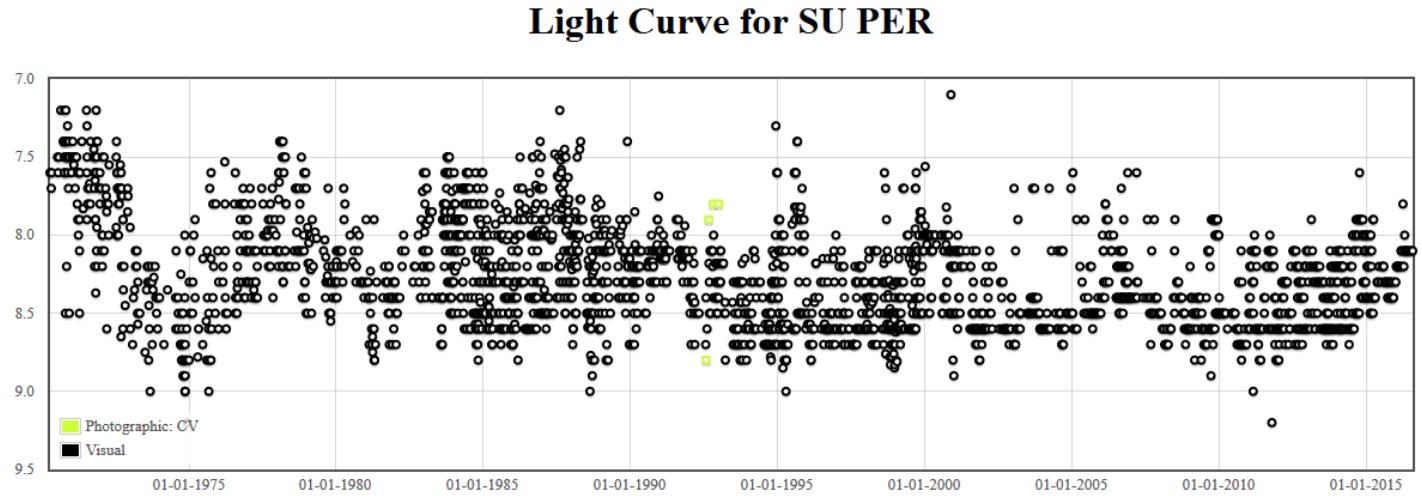
There are virtually no observations of U Del in the top 0.6 mag of the catalogued range, but the lower observed limit seems to good match for the bottom end. There are clear signs of a long term period of around 3 years.

Figure 4: TV Gem (Catalogued range 6.6-8.0, type SRc)



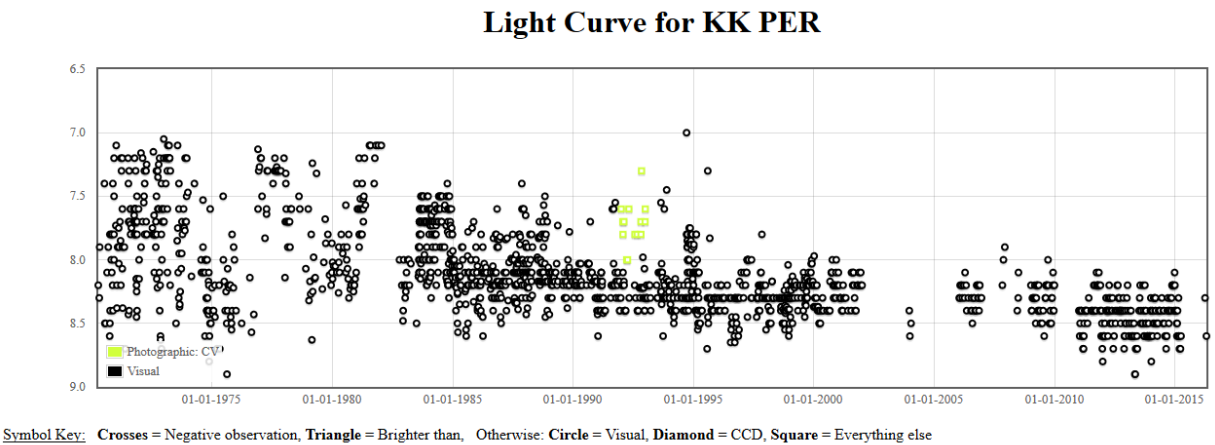
Although TV Gem spends most of its time in the upper part of the catalogued range, the brighter maxima and deeper minima push beyond the catalogued limits. There is a strong impression of a long term period of 6-7 years.

Figure 5: SU Per (Catalogued range 7.0-8.5, type SRc, period 533 days)



In the early years, SU Per seems to have varied over almost all of its catalogue range, quite often dipping just below the lower limit. However, there seems to have been a gradual reduction in amplitude, with the loss being primarily from the brighter end. There is no sign of the catalogued 533 day period, but there is a strong impression, especially in the early decades, of a long term period of 7-8 years.

Figure 6: KK Per (Catalogued range 6.6-7.9, type Lc)



Symbol Key: **Crosses** = Negative observation, **Triangle** = Brighter than, Otherwise: **Circle** = Visual, **Diamond** = CCD, **Square** = Everything else

At no stage does KK Per come close to the upper end of its catalogued range. Instead, from the mid 1980s onwards it seems to spend most of its time below the lower limit. The impression is of a slow fade. There is no sign of any long term periodicity.

Apologies to observers of these stars, whose names have not been included for each light curve due to there having been so many observers over the years and in some cases the list would take up more space than the light curve.

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The various priority levels of the Binocular Programme can now be found on the VSS web site at: ***http://www.britastro.org/vss/bin_prog_priority_191013.htm*** or for a full listing in constellation order at: ***http://www.britastro.org/vss/chartcat_binoc.htm***

These listings can be viewed in Circulars 157 - 160, and can be obtained in paper format from Shaun Albrighton and Roger Pickard (Contact details under Director and Binocular Secretary on back page of the Circular).

ECLIPSING BINARY PREDICTIONS – WHERE TO FIND THEM

DES LOUGHNEY - *desloughney@blueyonder.co.uk*

The publication of Eclipsing Binary Predictions is now discontinued in the VSS Circular. Predictions for RZ Cas, Beta Per and Lambda Tau can still be found in the BAA Handbook. Predictions, completed on a monthly basis, are available on the BAA VSS website at: ***http://www.britastro.org/vss/dpredict.html***

If readers require paper copies of the predictions please contact me.

The best source for predictions for Eclipsing Binaries is the Mt. Suhora Astronomical Observatory, Cracow Pedagogical University website (known as the Krakow website)at: ***http://www.as.up.krakow.pl/o-c/index.php3***

Click on 'Constellation List', choose your constellation and then choose your system.

A webpage will then appear with lots of useful information regarding the system. In the section entitled 'Light Elements' there is a link entitled 'current minima and phase'. When you click on this link, in the example of Beta Lyrae, you get predictions of primary and secondary eclipses for a period of three months. For systems with very short periods such as RZ Cas the predictions are for one week. For a system such as SW Cyg, with a period of around 4.57 days, the predictions are for a month.

The Krakow website does not tell you how much of an eclipse will be observable at a particular time of the year at your latitude and longitude. However, it has some useful literature references for each system, although they may not necessarily be up to date. Nor are references to the 'Information Bulletin on Variable Stars' included, but these can be found at: ***http://www.konkoly.hu/IBVS/IBVS.html***

Although the Krakow website lists the depth of eclipses it does not list the actual V magnitudes at maximum and minimum. For an indication of these magnitudes you will need to visit the 'General Catalogue of Variable Stars' website at: ***http://www.sai.msu.su/groups/cluster/gcvs/gcvs/***

Click on 'GCVS Query Form', type in a designation such as SW Cyg, and click on 'Search'. The resulting information displayed shows that maximum is 9.24V, primary minimum 11.83V, and secondary minimum 9.30V. These magnitudes, however, may have been determined some time ago.

The GCVS website gives SW Cyg a period of 4.57313411 days but the Krakow website lists the period of SW Cyg as 4.572986 days. The latter is more likely to list the most up to date period. It must always be borne in mind that small changes in a period can result in significant changes in the times of minima if the period was determined a few years ago.

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CONTRIBUTING TO THE CIRCULAR

If you would like to prepare an article for consideration for publication in a Variable Star Section Circular, please read the *Notes for Authors*, published on the web pages at:
http://www.britastro.org/vss/circs.htm; reproduced in full in VSSC132 p 22, or contact the editor (details on back cover) for a pdf copy of the guidelines.

If you are unsure if the material is of a suitable level or content, then please contact the editor for advice.

The **deadline for contributions** to the next issue of VSSC (number 170) will be 7th Nov 2016. All articles should be sent to the editor (details are given on the back of this issue).

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