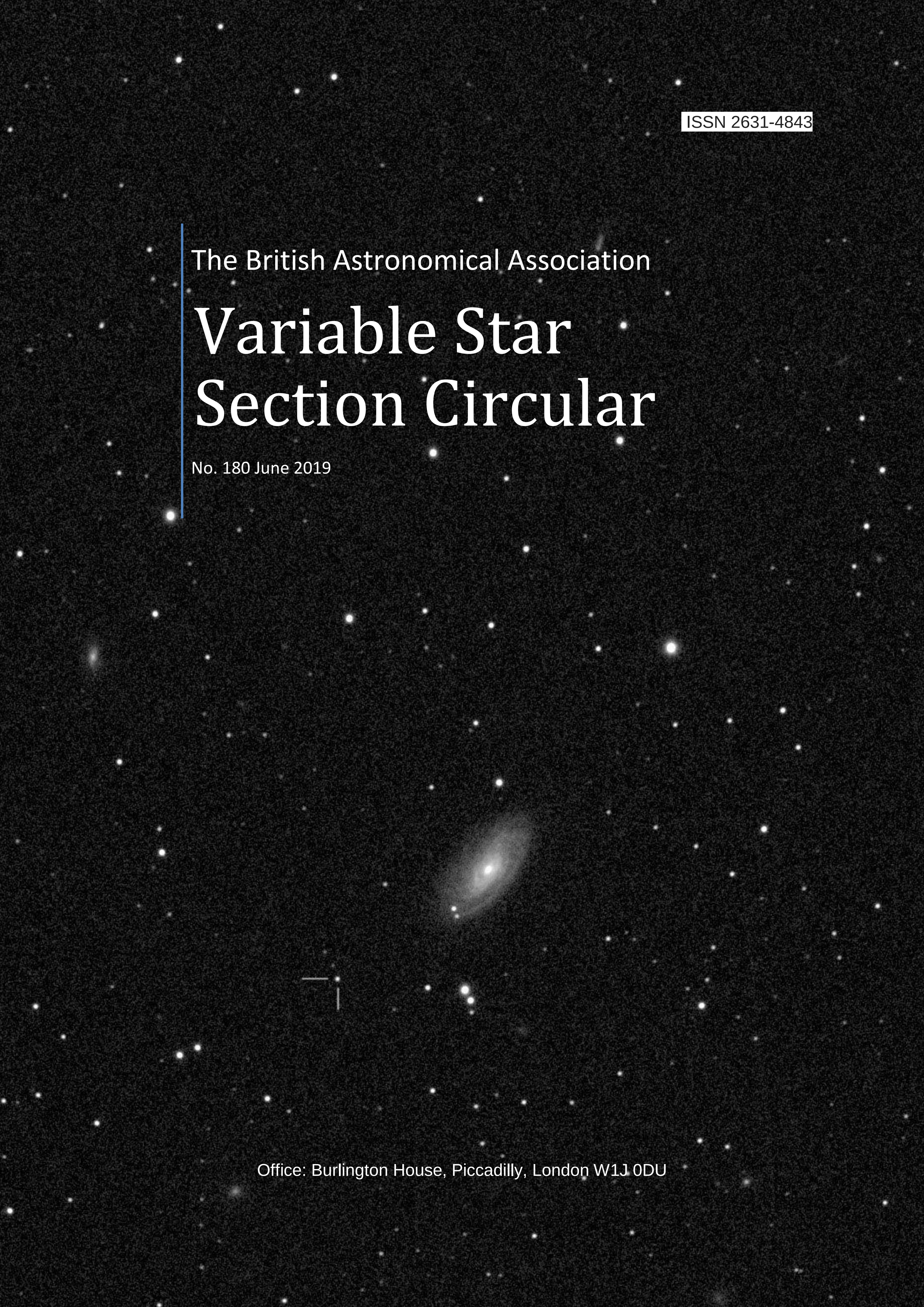

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The British Astronomical Association

Variable Star Section Circular

No. 180 June 2019

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Contents

Cover Picture

M88 and AL Com in outburst: *Nick James Chelmsford, Essex UK*
2019 Apr 29.896UT 90mm, f4.8 with ASI294 MC
Exposure 20x120s

From the Director	*Roger Pickard*

And so, with this issue I bid you farewell as Section Director, as advised in the previous Circular. However, as agreed with Jeremy and the other officers, I shall retain the title of Assistant Director, principally to help with charts and old data input. However, I shall still be happy to receive emails from members who I have corresponded with in the past, especially those I've helped under the Mentoring Scheme.

SUMMER MIRAS

M = Max, *m* = min.

R And	M=Aug/Sep
R Aqr	M=Jun/Jly
X Cam	*m*=Jun/Jly
SU Cnc	M=Aug/Sep
	m=Jun
U CVn	M=Jun/Jly
RT CVn	*m*=Jly
T Cas	M=Aug
o Cet (Mira)	*m*=Jun/Jly
R Com	M=Jly/Aug
S CrB	M=Aug
W CrB	*m*=Jun/Jly
R Cyg	M=Aug/Sep
S Cyg	M=Jun/Jly
V Cyg	M=Jly
chi Cyg	*m*=Jul/Aug
SS Her	M=Jly/Aug
	m=May/Jun
SU Lac	M=Aug/Sep
RS Leo	M=Aug/Sep
	m=Jun
W Lyn	*m*=Aug
X Oph	*m*=Jly
R Ser	M=May/Jun
T UMa	M=Jly/Aug

Source BAA Handbook

But a note on data submission. Some of you have been sending your "current" observations to the Pulsating Stars Secretary, Shaun Albrighton, but you should be sending them to the Section Secretary, Bob Dryden. He'd wondered why he was getting so few observations nowadays and wondered if you'd stopped observing!

I must also mention one of my "Data inputters" of really old data going back 10 of years if not longer (as with those observations that Alex Pratt has found in Melvyn's archive!). Alex Menarry has been entering these observations (as well as some of the more modern observations) for at least 15 years now, but what I had not realised is that Alex is now 86 years old! What is more remarkable is that he is a keen cyclist and recently cycled to San Marino with some friends for a holiday! But there is more! Last year he entered the Guinness Book of World Records when he cycled from Lands' End to John o Groats - see

http://www.guinnessworldrecords.com/world-records/oldest-person-to-cycle-from-lands-end-to-john-o-groats

and what's more, that's the second time he's done it! Congratulations Alex.

And of course, my thanks to Jeremy Shears for taking on this role and I trust you'll give him as much support as you've shown me over the years.

Many thanks and best wishes to you all,

Roger

A Note from the incoming Director

As this is Roger's last "From the Director column" before he hands over the reins, I thought it was appropriate to thank him on behalf of all Section members for the hard work and dedication he has put into the Section during the last 20 years. This, incidentally, makes him the longest serving Director since the Section was formed in 1890 – a remarkable record. He has seen quite a few changes in variable star astronomy in that time, including the advent of CCD photometry by amateurs and the emergence of large astronomical surveys, and has ensured that the Section remains relevant to today's variable star enthusiasts, both visual and CCD. He has promoted the VSS far and wide. He has also forged links with the professional research community, which rightfully holds the work of our observers in high regard. Other developments which he has overseen include the computerisation of the Section's historical and handwritten observations, as well as the updating of the VSS photometry database.

Roger leaves the Section in excellent health: certainly, one of the most active in the BAA. I am pleased to say that he will remain as Assistant Director as he mentions above, which will be a tremendous support for me. The specific tasks he has agreed to continue with are inputting old data in the database (this seems to be a never-ending task as more records come to light!) and approving new visual charts & sequences.

So, I wish Roger well in all the things he plans to do after retiring from the Directorship. I know that variables stars will feature prominently! I hope he will have more time for observing and I very much look forward to receiving his variable star observations for many years to come.

I will introduce myself in the next Circular, but I would like to take this opportunity of letting you know about the next VSS meeting which will take place on Saturday 9 May 2020 at the Humfrey Rooms in Northampton, courtesy of the Northamptonshire Natural History Society. Spring is usually a busy time for BAA meetings; therefore, I was keen to get our Section meeting on the calendar of the 2019/20 BAA session as soon as possible! This will be a great opportunity for Section members to present their work, so please do consider if you would like to give a talk.

Spectroscopy Software Training Workshop

Andy Wilson

I am pleased to announce the Variable Star Section in collaboration with the Equipment and Techniques Section are holding a 1 day Spectroscopy Software Training Workshop. It will cover the end to end processing of spectra using the commonly used software packages BASS Project and ISIS. We are lucky to have David Boyd leading the ISIS session and John Paraskeva (author of BASS Project) the BASS Project session.

This workshop should be of interest to a wide range of spectroscopists., from those just starting out and needing help with the basics, to experienced observers who wish to learn a new software package or are keen to refine their technique. The sessions will be interactive with the instructors demonstrating the processing spectra on a large screen. To get the most out of the workshop, attendees should bring along a laptop with BASS Project and ISIS installed. This will allow attendees to try out the processing steps for themselves and receive help if they get stuck.

The workshop is being held on Saturday 24th August 2019 from 10am to 5pm at the Birmingham & Midland Institute, 9 Margaret Street, Birmingham, B3 3BS. Thanks to the generous support from both Sections the cost is only £5 for members of the BAA and £7 for non-members.

More details can be found at the below web address for the BAA meeting page, and places can be booked via the BAA online shop: https://britastro.org/spectro2019

CV & E News

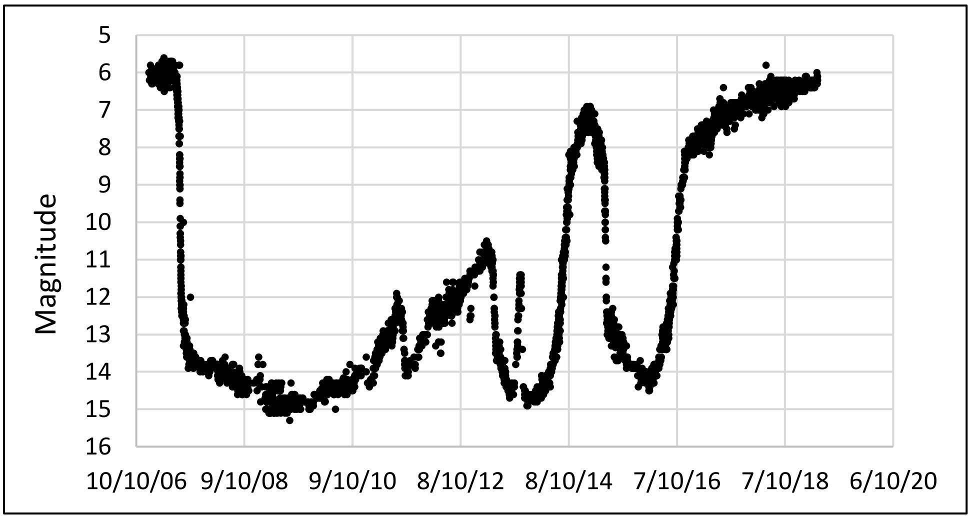
Gary Poyner

AL Com
The first outburst of this rather short period UGWZ star since March 2015 was detected by Masayuki Moriama (Nagasaki, Japan) on April 14.5 UT at magnitude 13.0C with a 20cm SCT + ST-8XME camera. AL Com is notable for lying just 8 arc minutes SE of the galaxy M88 (see cover image).

The outburst slowly faded to 14.8V by May 2nd then quickly declined to 16.55V two days later on May 4.9 UT. The first rebrightening was detected on May 06.8 UT at 15.4V and lasted 10 days until May 16 when the magnitude dropped to 17.2 mean by May 17. A second rebrightening occurred on May 18.8 UT at mean magnitude 15.7CV, fading to 17.6V by May 20.9. Superhumps were observed at amplitude 0.2 mag during the main outburst and rebrightening. Some images and discussion can be followed on the BAA forum here.

SV Sge
In VSSC 178 & VSSC 179, I have been reporting on the record deep fade and recovery of the RCB star SV Sge. The star has continued to rise slowly in brightness over the past three months, with one short pause of ~25d from April 11 – May 6 at magnitude ~12.1V, since when the slow ponderous recovery continued. By May 21 SV Sge had reached 11.7 visual.

R CrB
After spending twelve years below maximum magnitude, R CrB is now at its brightest level since the record decline began way back in 2007 and is so very nearly back to its usual maximum brightness levels. During 2019 the brightness has increased slowly - January 6.36 mean, February 6.29 mean, March 6.29 mean, April 6.29 mean and May 6.18 mean (BAAVSS DB). The catalogued maximum is given as 5.71V, so we haven't that far to go.



R CrB Jan 2007-May 2019, 4,500 observations. BAAVSS database

Z And
Jeremy Shears has brought to my attention a recent paper on the Symbiotic proto-type star Z And, a popular target for BAAVSS observers. The paper (*The activity of the symbiotic binary Z Andromedae and its latest outburst, Merc et al*) discusses photometric and spectroscopic observations during the most recent outburst in 2018. You can download the paper in PDF here.

BAA VSS campaign to observe the old Nova HR Lyr

Jeremy Shears

Introduction to HR Lyr: a century of observations

This year represents the centenary of the discovery of Nova Lyrae 1919. HR Lyr, as it is now known, was a magnitude 6.5 nova discovered on 1919 December 6 by Miss Mackie at the Harvard College Observatory. The decline from outburst was fairly well covered and showed a rapid (t_3 ~ 80 days) and smooth decline. A review of the photometric history of HR Lyr was present in the BAA Journal in 2007 [1], finding that the system has been relatively stable at V ~ 16 ever since occasional post-nova monitoring (initially visual observations) began in 1925. More recently, the 22-year light curve between 1991 and 2012 was presented [2] which showed the system varied over the range V= 15.3-16.3 with occasional excursions to V~17. One of these fades, in 2010, was discussed in the BAA Journal [3] and a further fade occurred in 2016. The light curve variations often take the form of nearly linear rises and falls on a timescale of about 100 days. Occasional ~0.6 mag outbursts were also seen, with properties similar to those found in some nova-like cataclysmic variables. Overall, there was a decline of 0.012 ± 0.005 mag/yr, similar to that seen in other post-novae.

Recent data from ASAS-SN suggests a period of 613 days, but this might not be statistically significant.

Scope and objectives of the 2019 campaign

Apart from photometric monitoring, HR Lyr has not received much attention. The aim of this campaign, which will run until the end of 2019, is to deepen our understanding of the photometric behaviour, on a range of timescales, as well as attempting to characterise its spectroscopic properties and variations.

It would be wonderful to shed some light on HR Lyr's behaviour some one hundred years after Miss Mackie's discovery!

Observations requested

Nightly photometry (visual and CCD)

To determine the overall light curve of HR Lyr during 2019, nightly observations are requested to provide a "snapshot" of how the star is performing and to monitor for the ~0.6 stunted outbursts that have been seen previously.

Observations can be visual (if you have a sufficiently large telescope) or CCD. V-band photometry is preferred, but if you do not have a V-filter, then unfiltered will also be acceptable. In addition, B- and R-band measurements will also be appreciated to see if there are any colour variations over the course of the campaign.

Sequences for HR Lyr can be downloaded from the AAVSO Variable Star Plotter [4]. The accompanying chart can be used for visual observations. Observations should be submitted to the databases of the BAA Variable Star Section or the AAVSO, preferably as soon as possible after the observation is made.

Time resolved CCD photometry

Rather little time resolved photometry is available for HR Lyr, so a major aim of the programme is to carry out several long photometry runs to see if there are any periodicities or other significant variations on a timescale of minutes to hours. A team at the Wise Observatory observing in the 1990's found quasi-periodic variations around the period 0.1d, which they speculated may be associated with the orbital period [5]. However, no independent measurement of the orbital period of HR Lyr has been published. Perhaps our work will confirm or refute this. Ideally, runs of several hours should be performed if we are to identify signals with a period of ~0.1.

Again V-band photometry is preferred (plus other bands if available), but if this is not possible, unfiltered is fine. Again, observations should be submitted to the international databases.

Spectroscopy

HR Lyr is even less well characterised spectroscopically than photometrically! Its Hα profile in 1993 and in 2008 was composed of a sharp central peak having a FWHM of ∼10 Å, plus a broad shallow base with typical FWHM of ∼40 Å. In the 1993 spectra no changes were visible from night to night [2]. However, the line profile changed between the two adjacent 2008 nights. The Hα line showed a sharp central peak alongside a broader base which is not common among old novae but is similar to the emission line profile described for the old nova DQ Her. There was no convincing evidence for a decline in the Hα line widths over the interval 1986–2008. The spectral appearance of HR Lyr during the 2010 dimming episode was quite different from that exhibited during normal quiescence; the 2010 spectrum was characterised by a smooth bluish continuum with superimposed strong emission lines [6].

Spectroscopy at various times during 2019 will be helpful to identify any changes in the spectrum (as found in 2008) and, if there are changes, whether these can be correlated with gross changes in the photometric light curve.

Spectroscopy of such a faint target represents a real challenge with amateur equipment. Almost certainly too faint for high resolution line profile measurements, it is probably just accessible with a low-resolution instrument. It will be interesting to see whether it is possible to get worthwhile results.

Communications

Updates on the campaign will be given from time to time via the BAA VSS Alert email group [7] and on the Forum of the main BAA website.

[1] Shears J. & Poyner G., JBAA, 117, 136 – 141 (2007)
[2] Honeycutt R.K., Shears J., Kafka S., Robertson J.W. & Henden A., AJ, 147, 105 – 113 (2014)
[3] Shears J. & Poyner G., JBAA, 120, 380 (2010)
[4] https://www.aavso.org/apps/vsp/
[5] Leibowitz E. M. et al., Baltic Astronomy, 4, 453−466 (1995)
[6] Munari U., Siviero A., Ochner P., & Dallaporta S., The Astronomer's Telegram, No. 9418 (2016)
[7] http://groups.yahoo.com/group/baavss-alert/

164·02 10′ FIELD INVERTED

HR LYRAE 18h 53m 25·1s +29° 13′ 38″ (2000)

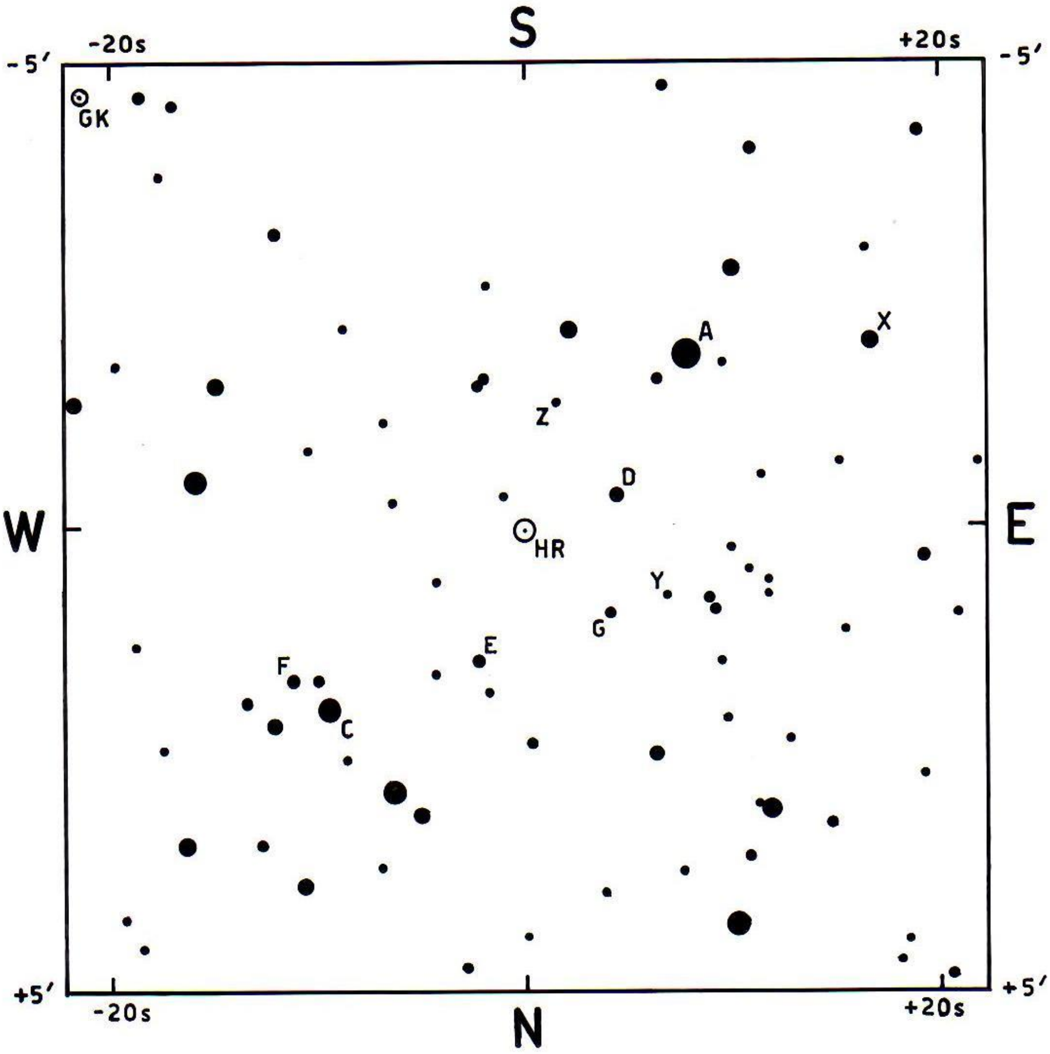


CHART:
DSS

SEQUENCE:
C RDP,
OTHERS SRO

A 12·1	F 15·1
C 12·9	G 15·6
X 13·8	Y 16·2
D 14·3	Z 16·7
E 14·6	

BAA VSS
EPOCH: 2000
DRAWN: JT 05-05-19
APPROVED: RDP

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Narrow Range Variables – made for digital observation

Geoff Chaplin

Narrow range variables are problematic for visual observation, especially late spectral type stars because of the relatively large range of variation in different observers' eyes' response to the red end of the spectrum. These stars are not well understood, and a rich long database of observations is essential for future study. A long run of data can help overcome visual observational noise but a better, and nowadays an available solution, is to reduce the noise. The narrow range of variability and the strong colour make these objects ideal for electronic observation ideally with a V filter, or DSLR observation.

Visual observation is helpful in order to relate visual and future electronic observations and in any event is likely to be more plentiful than electronic observations. Visual observers are encouraged to build up a series of over 100 observations, making observations no more frequently than once a week. However, we strongly recommend the use of CCD/DSLR equipment as outlined below to overcome the problem of the substantial component of observational and atmospheric noise in data. A good consumer digital camera and 200mm lens on an equatorial mount is sufficient to produce high quality data for many of these objects. Software (AIP4WIN or MaximDL for example) may report an accuracy of 0.001 in the calculated magnitude of the variable, but this is misleading. This is just the reduction accuracy given the data selected from the image file. But sky conditions vary minute by minute and the reality is a single short exposure frame may only be accurate to 0.1 magnitude – little better than a visual observation (see charts below). Electronic observations should ideally be a set of 30 to 100 observations to reduce the error in the mean to 0.01 magnitude or less. Observers should report the entire series of observations, not just the calculated mean.

It should be noted that with short focal length instruments (500mm or less) it may be possible to fit several variables on one 35mm frame sensor making data collection (and often reduction too) efficient. For example, six or more variables near RS Per will fit on a single 35mm frame.

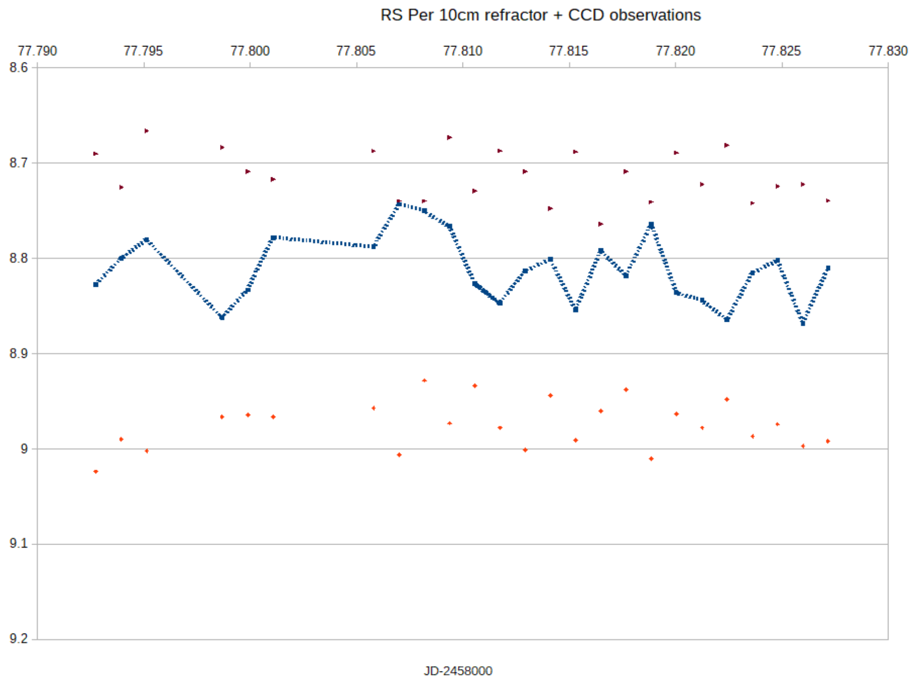


Figure 1. CCD observations by the author using T14 (106mm Takahashi APO and SBIG STL-11000M camera) from New Mexico site at elevation of 2200m. Connected line – RS Per – upper- and lower-marks comparison star magnitudes

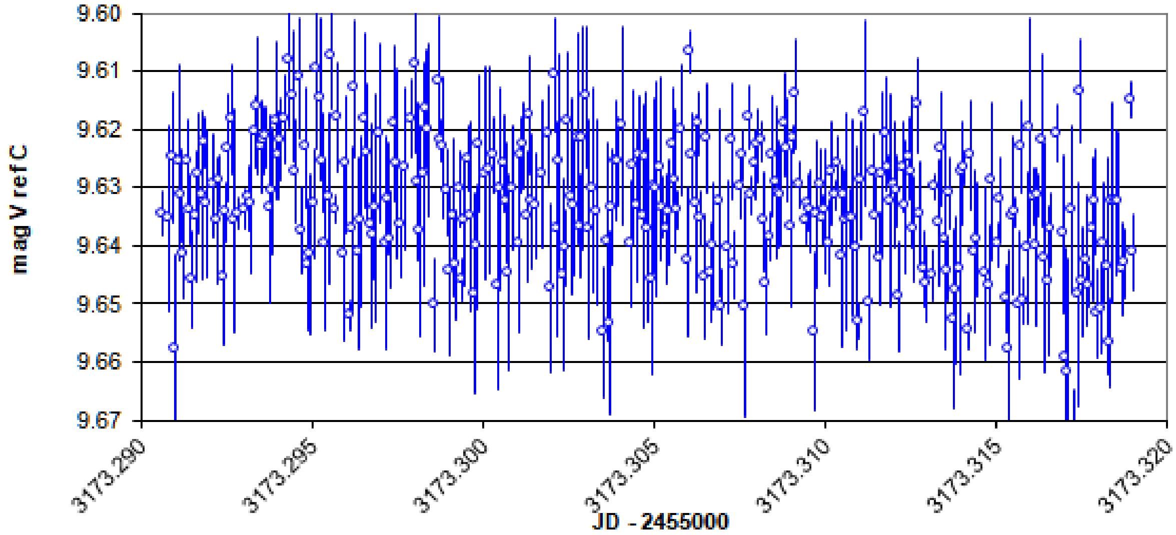


Figure 2: CCD observations by Roger Pickard using C14 and CCD camera. RS Per with calculated error bars

Note: This article is based in part on Chaplin, G.B, JAAVSO, volume 47, number 1, 2019, copyright 2019 The American Association of Variable Star Observers, used by permission.

AB Aurigae

John Toone

AB Aur was discovered to be variable by Miss M D Applegate working at Harvard College Observatory in 1921. From examination of 150 plates taken between 1914 and 1921 she reported a photographic range of 7.0 – 8.9. It was bright most of the time but there seems to have been fades in November 1914, March/April 1916 and September 1917. Professor Yamamoto conducted a more extensive study of 800 Harvard plates between 1898 & 1923 and reported a range of 7.2 – 8.4 with the star being at maximum most of the time but on 11 occasions it had faded to magnitude 8. The two deepest fades to magnitude 8.4 occurred between 28 February & 6 March 1906 and 4 March & 8 April 1916. The spectral class was type A0 and up to that time all variables of early spectral class were either eclipsing binaries or short period Cepheids but AB Aur was exhibiting irregular behaviour and clearly something different. Initially Merrell & Burwell in their catalogue of A & B stars with hydrogen emission lines classified AB Aur as type RCB.

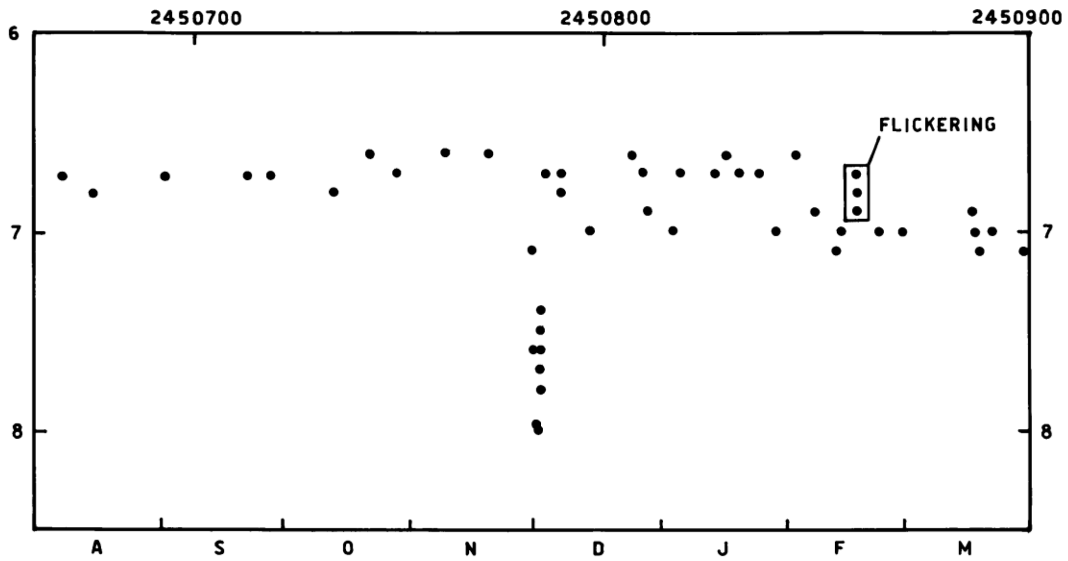
AB Aur eventually became classified as the Northern hemisphere's brightest Herbig Ae pre-main sequence star with a luminosity of 47 times that of the sun. At a distance of 455 light years, it has a mass 2.4 times that of the sun and is younger than the earth at just 2 billion years old. AB Aur is also surrounded by a dust disk from 0.24AU to 300AU inclined at 21 degrees so it is almost face-on to the Earth. This dust disk has some spiral structure and there is evidence that it might be in the process of planet forming.

For long spells AB Aur does not show much variation. The Hipparcos mission in 1989-1992 made 40 measurements of AB Aur but only detected 0.06 magnitude variation. Continuous high precision photometry by the MOST telescope over 24 days in 2009/10 indicated only 0.1 magnitude variation but there did seem to be an average period of 6.55 days. Previous high precision measurements over short timescales by other sources indicated periods between 0.5 and 1.8 days over a similar variation range.

AB Aur lies just 8 degrees north of the Ecliptic, so the moon often interferes with monitoring for a few days each month but from the UK the observing apparition is from the last week of July through to the first week in May. Just 3 arc minutes following AB Aur lies SU Aur a UXO variable of spectral class G2 that is physically associated with AB Aur with the pair being approximately 27000AU apart.

Surprisingly AB Aur was not observed regularly until the 1960's and it seemed for a while that the frequent fades recorded photographically at the turn of the 20th Century had discontinued. Then on 29 November 1975 and 30 November 1997 visual observers in the UK detected two strikingly similar fades with a depth of 1.2 magnitude and duration of only 70 hours. The rate of decline and rise of the 1997 fade was measured at 0.1 magnitude/hour. The accompanying light curve illustrates the 1997 fade, note the different form of variation post fade (including flickering) compared with beforehand, indicating an abrupt change in medium. Further information on the 1997 fade is given in VSS Circular No 95, page 13 (March 1998).

The separation of the 1975 and 1997 fades is almost exactly 22 years and projecting forwards by 22 years will lead to early December 2019, hence the reason for releasing this article at this time. Observers are therefore urged to pay special attention to AB Aur throughout the 2019/2020 apparition that commences in the second half of July 2019.



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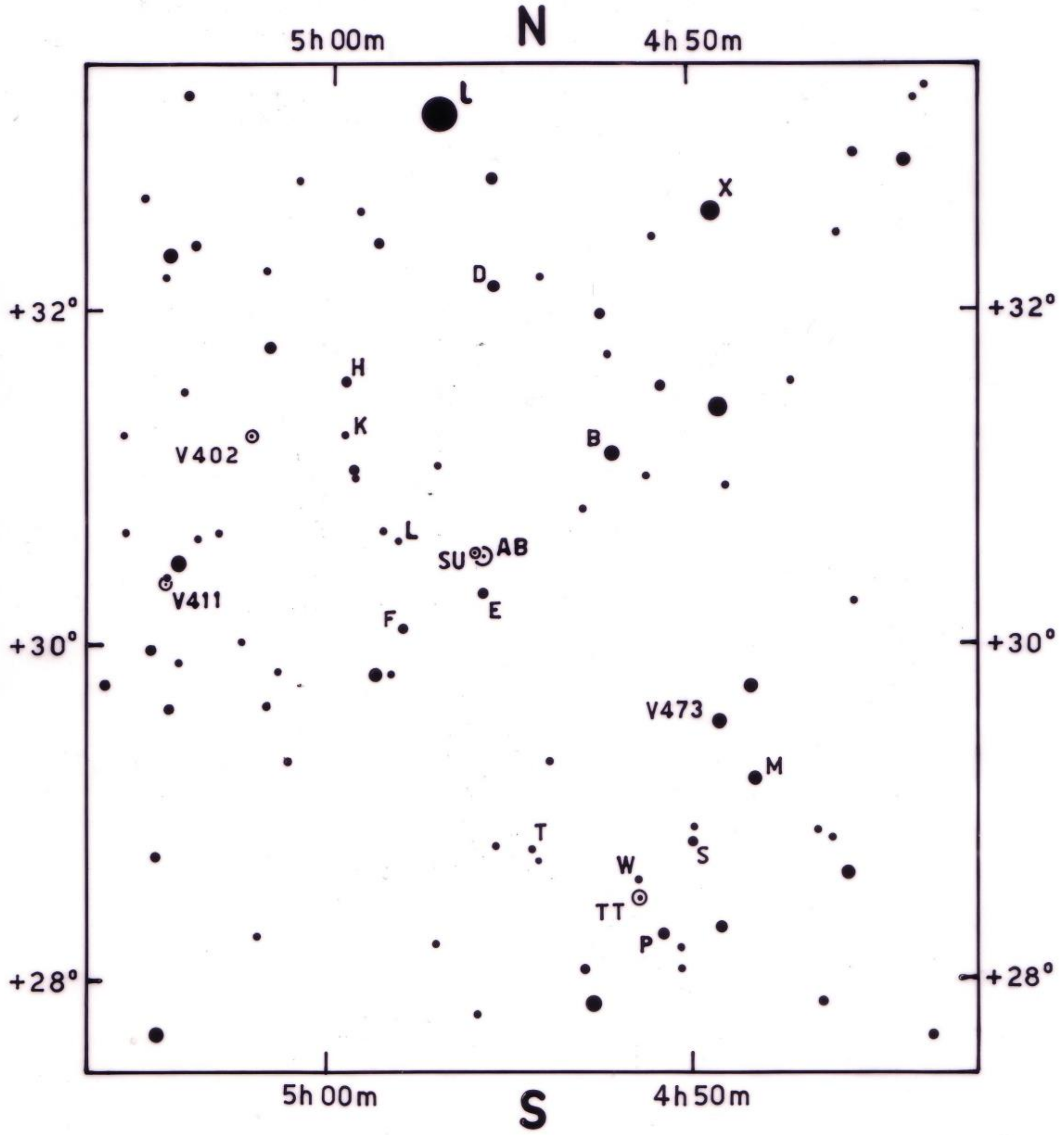
TT TAURI 04h 51m 31·3s +28° 31′ 37″ (2000)



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B	6·7	M	6·9
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E	7·6	S	8·1
F	8·0	T	8·8
H	8·2	W	9·6
K	8·6		

BAA VSS
EPOCH: 2000
DRAWN: JT 05-08-06
APPROVED: RDP

The Symbiotic Star AG Draconis

David Boyd

Symbiotic stars are wide, long-period binary systems comprising a cool red K or M type giant star and a small hot companion, usually a white dwarf, which is accreting material from the stellar wind of the cool giant. The wind forms a nebula in which both stars are immersed. The spectra of symbiotic stars show strong nebular emission lines of H I and He II as UV radiation from the hot white dwarf excites and ionises the nebula. The spectra of many symbiotic systems also show two broad emission features at 6825 Å and 7088 Å, features which are only seen in symbiotic stars with high-excitation nebulae. These are due to Raman scattering of the O VI 1032 and 1038 Å resonance lines by neutral hydrogen close to the cool giant star.

AG Dra is a symbiotic binary with an orbital period of about 550 days. The red giant is a K3III star and the hot component a white dwarf, possibly with an accretion disc. After quiescent behaviour from 2008 to 2015, AG Dra has experienced four outbursts at approximately one-year intervals during the past four years. Figure 1 shows my V magnitude measurements between June 2015 and the present. In two of these outbursts the star reached V magnitude 9.6 while in the other two it rose to 9.2. The B-V colour index is strongly correlated with V magnitude becoming bluer as the system brightens as shown in Figure 2. AG Dra is currently rising to another outburst which, if it follows the pattern of the past four years, will most likely be a weak one.

Besides monitoring its V magnitude, I have been recording low resolution spectra with a LISA spectroscope on a C11 scope. By flux calibrating these spectra using concurrently recorded V magnitudes I am able to calculate the spectral energy distribution of these spectra in absolute flux units of erg/cm^2/sec/ Å. Figure 3 shows a recent spectrum of AG Dra with prominent spectral lines identified. These include the two O VI Raman lines mentioned above.

As the spectrum is calibrated in absolute flux, I can measure the flux of emission lines in the spectra including the hydrogen Balmer line Hβ 4861 Å and the ionised helium line He II 4686 Å. From the ratio of the flux in these lines it is possible to compute a proxy for the temperature of the white dwarf using the formula

$$T_{WD} = 14.16 * SQRT(flux(4686)/flux(4861) + 5.13) * 10000 \text{ K} \quad (1)$$

Figures 4 shows the variation of these two emission lines and the computed white dwarf temperature over the past four years.

Time will tell whether the current outburst will be a strong one or a weak one. The pattern so far suggests it will be a weak one but whether AG Dra recognises this pattern remains to be seen. Only by observing it over the next few months will we find out.

My spectra are reported to the ARAS and BAA spectroscopic databases where they are available for any subsequent professional analysis.

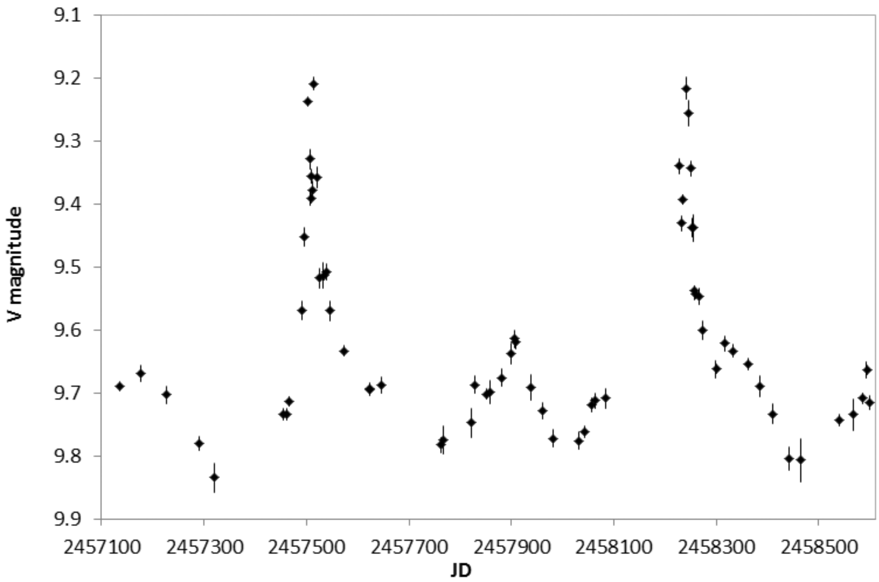

Figure 1. V magnitude light curve of AG Dra from 2015 to 2019.

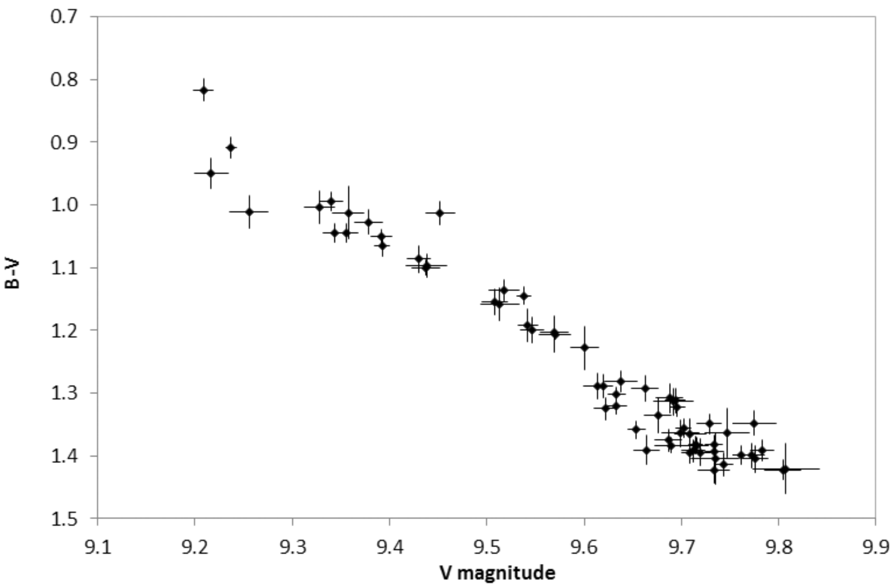

Figure 2. Variation of the B-V colour index with V magnitude.

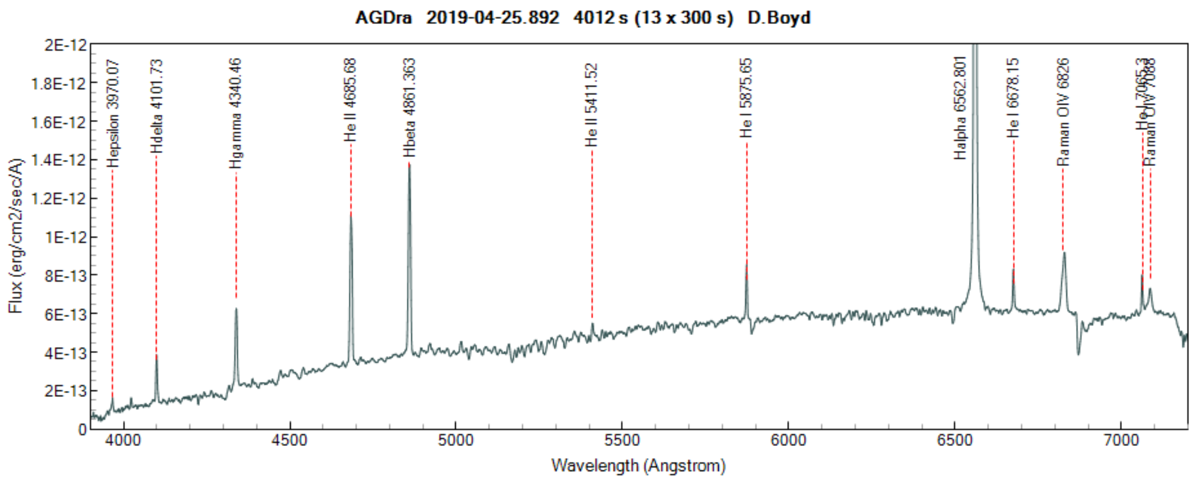

Figure 3. Spectrum of AG Dra taken on 2019 April 25 with prominent emission lines identified

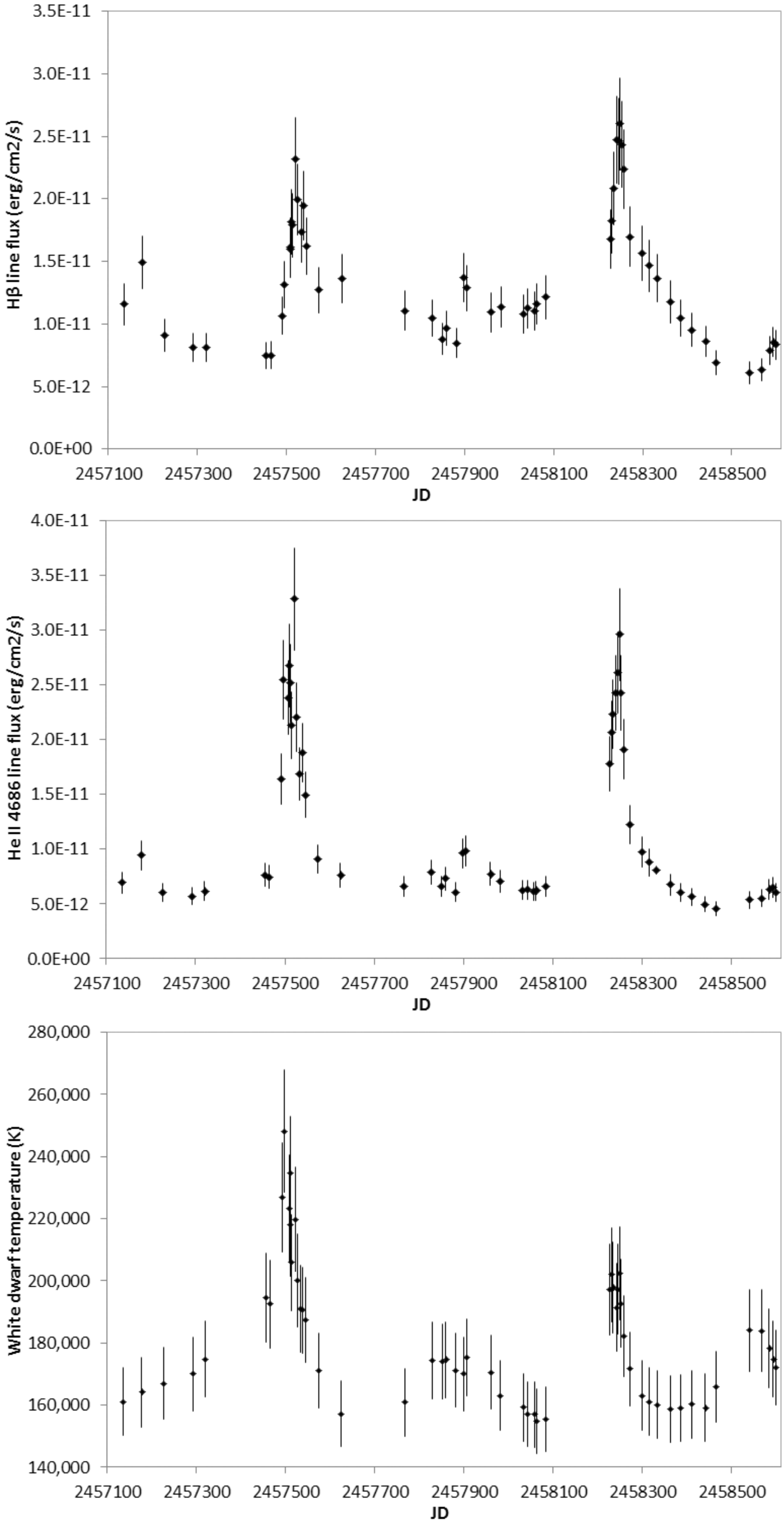

Figure 4. Variation of the Hβ 4861 Å line flux (top), He II 4686 Å line flux (middle) and proxy white dwarf temperature given by eqn (1) (bottom).

V Boötis Revisited

John Greaves
cpmjg@tutanota.com

Abstract: *Updated V Boötis data from the British Astronomical Association's Variable Star Section's visual database is assessed with respect to the progression of the amplitude of variation as predicted in past analyses.*

Introduction

Nearly one score and zero years ago the trend and phenomenological nature of V Boötis' decline in amplitude was illustrated in Greaves & Howarth (2000) using Howarth's "AMPSCAN" procedure (e.g. Howarth & Greaves (2001)) upon data provided by the British Astronomical Association's Variable Star Section (BAAVSS). Following on from this article Ondrej Pejcha noticed something from the presented plots and felt that this could be explained by amplitude modulation of two very close periods, the details of the follow up analysis appearing in Pejcha & Greaves (2001). There it was predicted that the amplitude decrease was in fact the result of an amplitude modulation between a 257.8 day and 259.2 day pair of primary periods whilst the secondary period of 137.1 days remained relatively stable over that time (the existence of a second shorter period for SRb variables is almost a definitive diagnostic). Now, roughly two decades later the BAAVSS' up-to-date data is used to assess whether Pejcha's implied prediction of an end to the decline phase followed by an amplitude increase has any empirical evidence to support it.

Result

Figure 1 presents the semi-amplitude (loosely half the full amplitude, but here based on the Fourier fit to the light curve, not the actual raw light curve value) in visual magnitudes over Modified Julian Date time for the same dataset extended to the current epoch. It is directly comparable to Figure 8 of Greaves & Howarth (2000) and comparable to the top panel of Figure 3 in Pejcha & Greaves (2001), at least in terms of the longer primary period for this latter. Direct links to online archives of these figures are given at the end of the paper to allow ease of comparison. The earlier figures end at around JD 2450000 whilst the current figure ends around one year short of JD 2459000. The general trends are mappable from one to the other, though some are smoother in illustration due to the data having been processed at differing time interval rates for all three analyses.

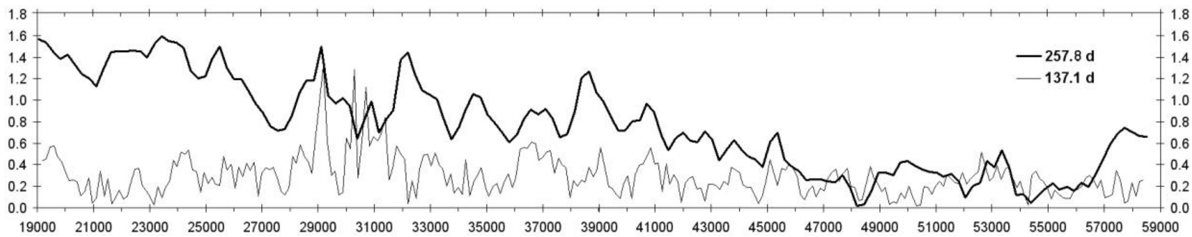

Figure 1: The semi-amplitude against Modified Julian Date for BAAVSS visual observations for both the 257.8 day and 137.1-day periods of V Boötis. The *y* axes are semi-amplitude in visual magnitudes and the *x* axis is Modified Julian Date (JD – 2400000). Click here for larger image

For the earlier Figure 8 and the current Figure 1 the erratic nature of the plot at one point is related more to a dearth of observations between around MJD 29000 to 31000+ as can also be seen from

Figures 1 and 2 of Greaves & Howarth (2000). In the current Figure 1 it can still be seen with an erratic plot in this time interval due to the AMPSCAN procedure acting as a “moving window” as it analyses adjacent areas across a light curve such that in this time interval it is often comparing measures against nothing, or nothing against measures. Other than that, the peaks and troughs in the semi-amplitude over time plots are readily comparable for both the long and short periods of this semiregular variable.

Throughout it can be see that the 137.1-day period, although erratic as expected for a semiregular variable, is pretty much stable with no particular trend towards either amplitude increase or decrease beyond an overall mean. The 257.8-day period has declined in amplitude since the first observations in nearly 90 years of BAA data. However, from around JD 2447000 or so it too could be easily representative of generic erratic semiregular light curve behaviour about a mean amplitude with no trend in either decline or increase. In fact, it could almost be said from the current data that at times V Boötis’ amplitude of variation between MJD 47000 to MJD 57000 was almost solely due the amplitude of the 137.1-day secondary period! If all this was the result of some evolutionary process and fundamental change in the structure of the star that could well have been it, with no change or something totally different happening thenceforth.

On the other hand, Pejcha’s amplitude modulation model implies (though doesn’t explicitly state) that in time the amplitude should again start increasing monotonically about a mean. This is somewhat analogous to the long-term light curve trend the Blazhko Effect superimposes upon the basic period of some RR Lyræ variables, recently thought to be related to amplitude modulation due to resonances based on analyses of Kepler data (e.g. Szabo et al (2010) especially Figure 3). Time has passed and Figure 1 here suggests the amplitude of the longer primary period has indeed begun to increase again. It is still too early to be certain as throughout the observational history of the star the mean trend in amplitude has many erratic deviations from that trend superposed upon it. Yet it can be seen that the star’s amplitude of variation has doubled to trebled in recent time, approaching a level not consistently seen for ten thousand or more days.

As always, only time will tell. At least another half a dozen years to a decade will be needed to show that the recent increase in amplitude is not a passing blip and it will more likely be another decade or two by which time no one may be doing visual observations anymore and further some of us might not be here to do the final analysis. Yet if the increasing trend does continue then the raw visual light curve should be more than illustrative enough to demonstrate the case. It seems that this object was already in the declining amplitude trend from the first observations listed and it would be something of a cosmic coincidence if that had happened to be at the amplitude peak, although admittedly as a semiregular variable it can’t have been too much higher. A plateau time interval of near constant amplitude around the maximum level would be likely however, if only in analogy to the Blazhko Effect case. Accordingly, there is nothing much concrete said about the longest modulation period as barely half of it has passed in over a century of observation and the author isn’t entirely sure how to go about addressing that.

Acknowledgement This analysis uses data provided by the British Astronomical Association’s Variable Star Section’s online photometric database at http://britastro.org/photdb/ and of course all the observers who have contributed to it, both past and present. The ADS Abstract Service provides the archive article links.

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Greaves, J. & Howarth, J. J., 2000, *Journal of the British Astronomical Association*, vol.110, no.2, p.84

Howarth, J. J., Greaves, J., 2001, *Monthly Notices of the Royal Astronomical Society*, Volume 325, Issue 4, p. 1383

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Szabó, R., Kolláth, Z., Molnár, L., Kolenberg, K., Kurtz, D. W., Bryson, S. T., Benkő, J. M., Christensen-Dalsgaard, J., Kjeldsen, H., Borucki, W. J., Koch, D., Twicken, J. D., Chadid, M., di Criscienzo, M., Jeon, Y.-B., Moskalik, P., Nemec, J. M., Nuspl, J., 2010, *Monthly Notices of the Royal Astronomical Society*, Volume 409, Issue 3, p. 1244

Links to online journal archive figures

Figure 8 Greaves & Howarth :-
http://articles.adsabs.harvard.edu//full/2000JBAA..110...84G/0000086.000.html
Figure 3 Pejcha & Greaves: -
http://articles.adsabs.harvard.edu//full/2001JAVSO..29...99P/0000103.000.html
Figures 1&2 Greaves & Howarth :-
http://articles.adsabs.harvard.edu//full/2000JBAA..110...84G/0000084.000.html
Figure 3 Szabo et al :- https://academic.oup.com/mnras/article/409/3/1244/1106819#19934072

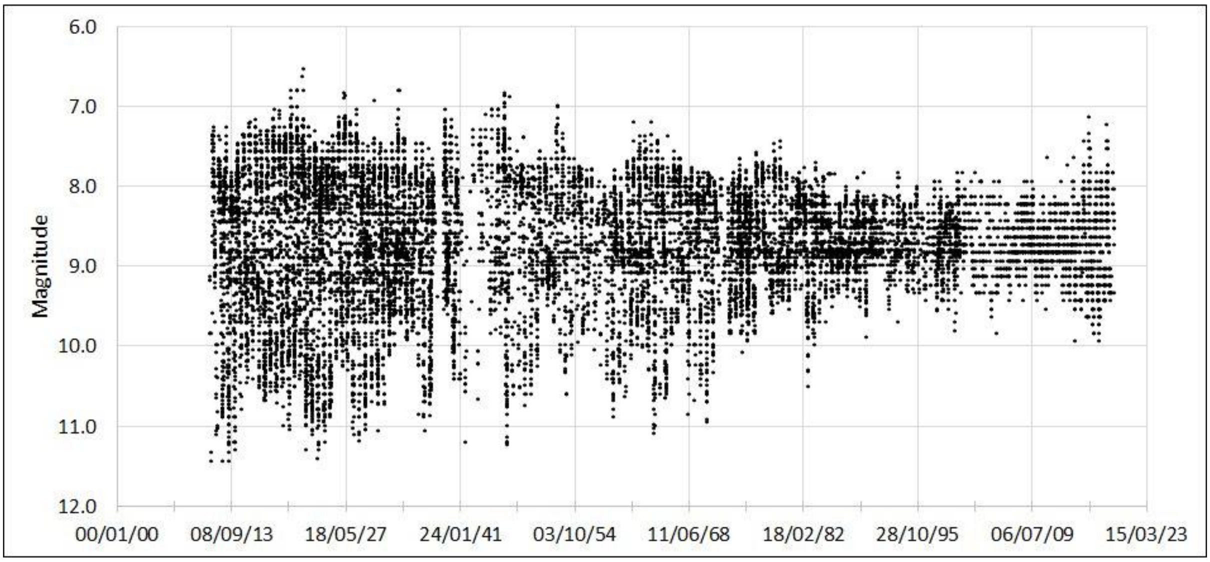


Figure 2: V Boötis.1911-2019. 15,604 observations. BAAVSS database

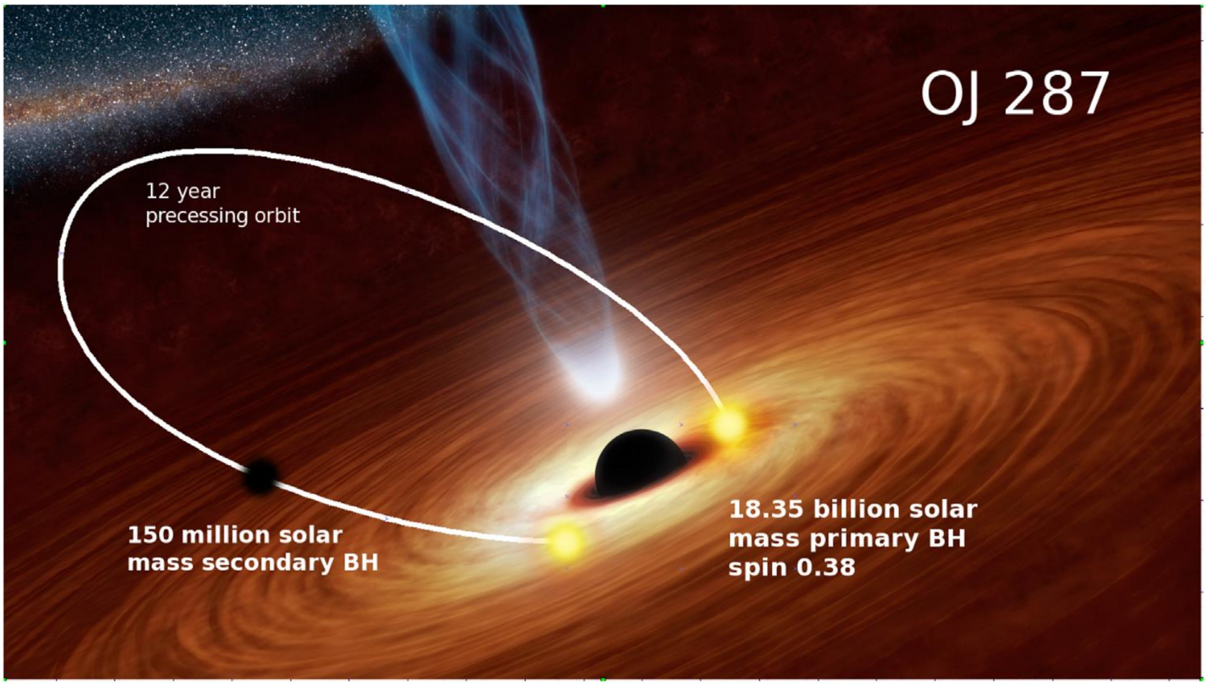
OJ287: Astronomers Asking if Black Holes Need Wigs

Mark Kidger

European Space Agency
European Space Astronomy Centre

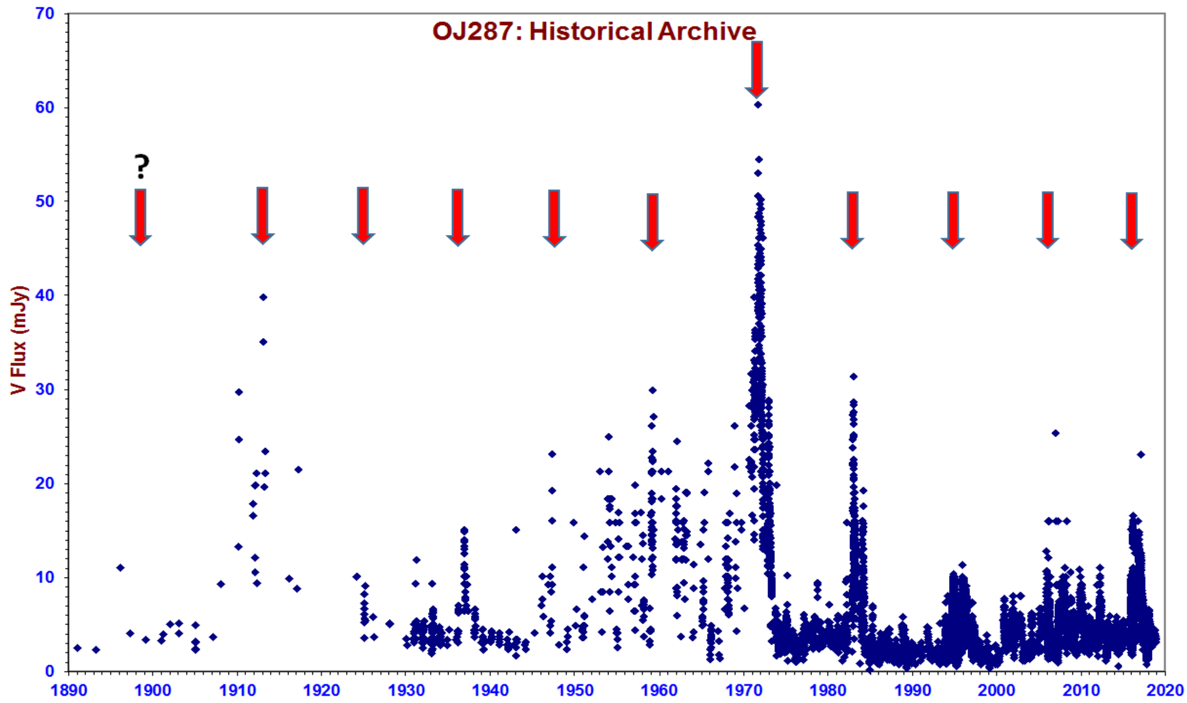
When you think of black holes, it is a fairly safe bet that you think of accretion disks and not wigs. After all, you only need a wig if you have no hair. That though is precisely what observers are trying to establish with observations of the latest superflare of the blazar, OJ287.

Over the last one hundred and thirty years, OJ287, a highly active quasar with a redshift of 0.306, indicating a distance of some 3200 million light years, has shown a well-known series of outbursts separated, on average, by about 11.9 years. That much is not in doubt. The interpretation of this light curve as the consequence of the orbital motion of two supermassive black holes is also fairly well accepted. The orbit of the secondary is quite eccentric and, each orbit, it passes through the accretion disk of the primary both at the descending and the ascending node, giving two major outbursts.



When the secondary passes through the accretion disk of the primary, there is a massive in fall of material onto the primary, causing a surge of accretion and a large flare in brightness. This is not instant: there is a time delay of 13 months between impact and outburst, so everything that we see is a delayed effect of previous events.

Because there is an impact both at descending and ascending node in the orbit, we see two outbursts. These are usually separated by about a year. However, relativistic effects mean that the perihelion advance of the orbit is huge. We see this perihelion advance in the modulation of the light curve amplitude. Look at the historical light curve below, represented as fluxes, rather than magnitudes.



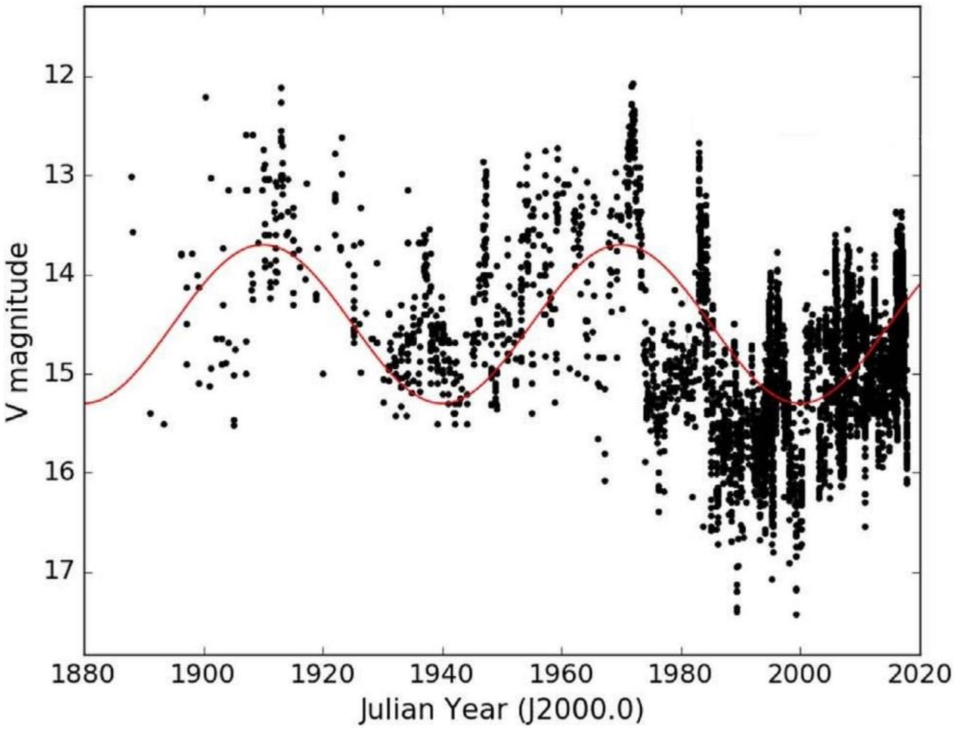
The 1913, 1960, 1972 and 1983 outbursts were big. In contrast, look how feeble the 1924, 1936 and 1994 outbursts were. There is an apparent secondary period in the amplitudes and, since 1994, they have started to increase again: the 2015 peak was the brightest that OJ287 has been seen for thirty years. This amplitude cycle is due to the precession of the orbit of the secondary. By fitting the long-period cycle, we get the precession rate of the orbit, now estimated to be 28º per orbit – a mere forty thousand times greater than the precession rate for Mercury's orbit.

This precession also makes the interval between the two nodal crossings vary from orbit to orbit and, on this occasion, it is exceptionally long, at three and a half years, practically triple the usual interval. The first nodal crossing happened in November 2014, an exceptionally short interval from the previous one, and the second, in June 2018, although the light signal from its impact is yet to reach us.

We know now that the 1972 outbursts came close to being the perfect alignment of the orbit to have the largest possible outburst. The 1972 outburst was exceptional in that OJ287 reached magnitude V=12.0, surpassing the previous historical record of V=12.5 recorded on January 27th, 1913. You may wonder how bright OJ287 can get, in theory, if everything aligns perfectly. The estimate from the model of the light curve is that it would become binocular visible, reaching V=9!

One of the big complications of OJ287 is that, being a supermassive black hole binary, a full calculation of the orbit involves far more than calculating the two masses and the eccentricity. In fact, with the different relativistic effects, there are no fewer than sixteen free parameters to fit. And, over the years, the quantity and quality of available data has increased massively. From 1891 – the first known observation – to 1930, there is a fraction more than one point per year. From 1930 to 1970, about 250 points per year. From 1970 to 1990, about 100 points per year. And then, in 1994 alone, 4290 observations. This means that the recent data has a huge impact in the overall fit, but it is the older and less reliable data that constrains many of the parameters. However, with each well-observed outburst, the time base increases and the uncertainties in the fit decrease.

A further huge advance made recently has been to augment the light curve above with some six hundred additional observations from the Harvard plate collection, although many are of marginal quality. This has allowed some of the older and more doubtful outbursts to be much better defined.



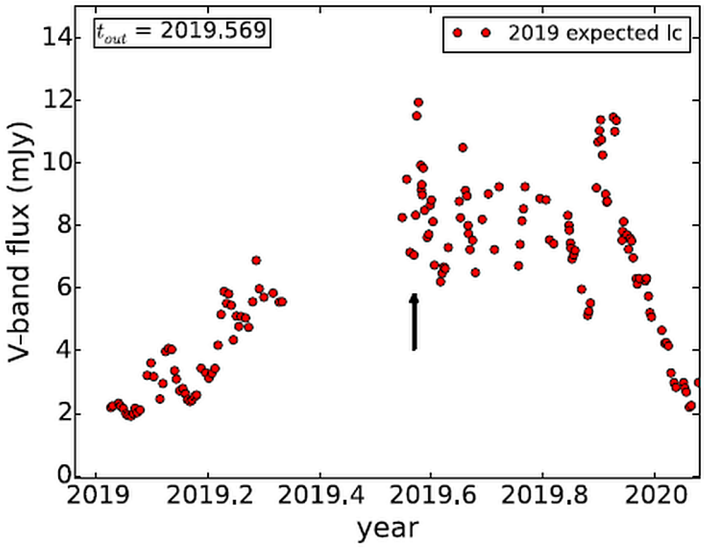
The improvement in the definition of the older outbursts and the long-term modulation of the light curve is very clear. We can see this improvement in some of the most basic parameters, as they were estimated in 2011, from data including the 2006 and 2007 outbursts and as they are estimated now, after the 2015 outburst and including the newly incorporated historic data.

	2011	2017
Primary Mass ($M_\odot$)	1.71×10^{10}	1.83×10^{10}
Secondary Mass ($M_\odot$)	1.4×10^{8}	1.50×10^{8}
Eccentricity	0.678	0.657
Precession (°/yr)	33.2	28

These four parameters are now quite stable and allow other terms, such as the spin of the black hole to be estimated. In fact, as the first estimate of the primary black hole mass, made in 1988, was of $1.8 \times 10^{10} M_\odot$, we can see that this value has hardly changed at all in thirty years, although others, such as the precession has. Observations of the 2015 outburst give a black hole spin for the primary of 0.31±0.01.

What of 2019?

Here is the theory:



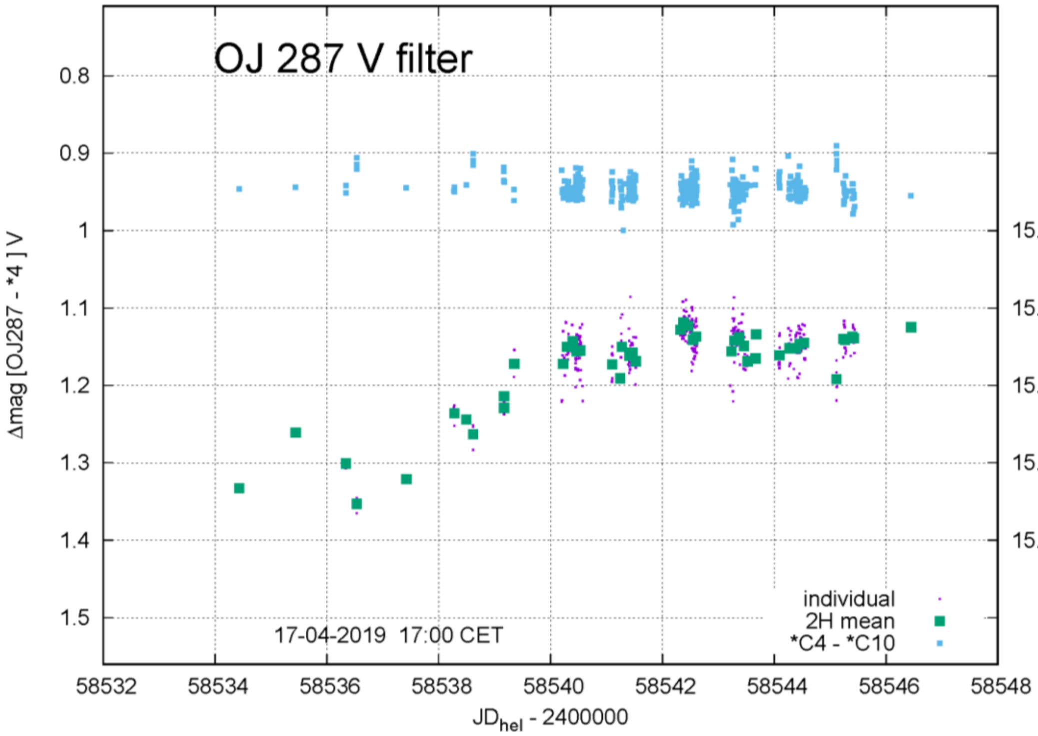
This light curve, taken from Dey et al., The Astrophysical Journal, 866:11 (2018), shows a steady rise through early 2019, a flat maximum lasting four to five months and a sharp flare of amplitude approximately 0.5 magnitudes on July 31st, 2019.

The model reaches such a level of detail that the peak of the flare can be predicted firmly to be 2019 July 31st 12:00UT, with the fast rise starting approximately 48 hours previously. However, one source of uncertainty is the so-called "Gravitational Radiation Reaction" (RR) term. This is the loss of energy of the system to gravitational radiation. The July 31st 12:00UT timing includes the higher-order RR terms that are predicted by General Relatively in a strong gravitational field and which provide an extreme test of the predictions. Were we to remove these terms, the maximum would be around 38 hours earlier.

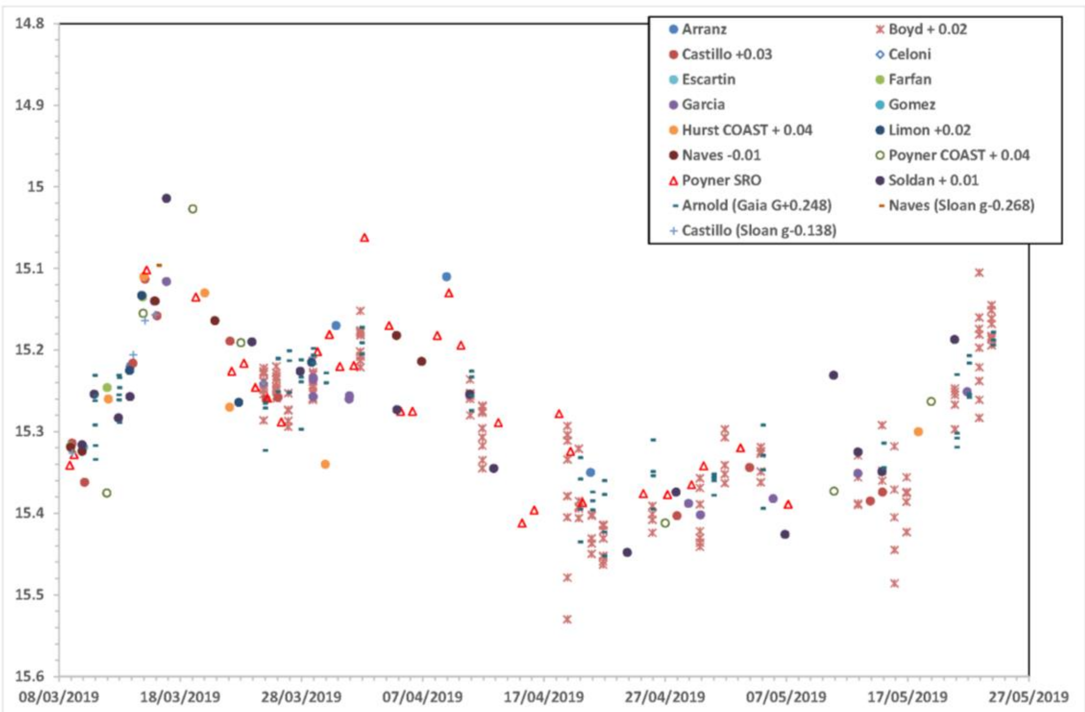
And here lies the rub. The application of the higher order terms for emission of gravitational are correct if black holes have no hair. If they are hairy, those terms need not apply.

Translated into everyday language, if the maximum occurs around the middle of July 31st, it means that black holes are really very simple objects. "Simple" means that OJ287 will have demonstrated that any black hole can be described completely by just its mass, its spin and its electric charge. Unfortunately, on July 31st, OJ287 is 6º from the Sun as seen from Earth. It will just come into visibility for NASA's infrared Spitzer telescope, now drifting away from Earth and due to be switched off in 2020. OJ287 will just get far enough away from the Sun for Spitzer to see it on July 31st. It will also be visible to the Parker Solar Probe and WISPR, its wide-field imager. Spitzer will observe in the infrared every 6 hours from the moment that the quasar becomes visible and, with luck, will catch the peak of the superflare. The Parker Solar Probe is more ambitious. Magnitude 13 is right at the limit of its capabilities, but OJ287 may just reach visibility at peak. If it does, the mere fact that it can be (just) seen at one moment and is invisible before and after, helps to time the maximum. A point every 6 hours means timing the maximum to about ±3 hours, if we are lucky. This allows us to prove the No Hair Theorem to ±10%.

If OJ287 cannot be observed from Earth, where do the amateurs come in? We need to know the visible equivalent of Spitzer's infrared magnitudes – it will measure in the L and M bands at 3.5 and 5 microns. To do this there was a major campaign of simultaneous observation of OJ287 by Spitzer and ground-based observers in the second half of February 2019. This included almost 220 points in V from a multitude of observers in the United Kingdom and in Spain.



Exact timing of the maximum in 2026 will allow the No Hair Theorem to be proved to ±3%. However, up until early May there was no sign that OJ287 had any intention to rise to outburst. As it sank lower and lower into the evening twilight, a timid rise started. As May ends and the last few days of observing before conjunction approach, that rise is getting faster and more obviously a rise to outburst. It seems that OJ287 is not going to fail us; we may yet see whether or not it wears a wig.



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Project Melvyn

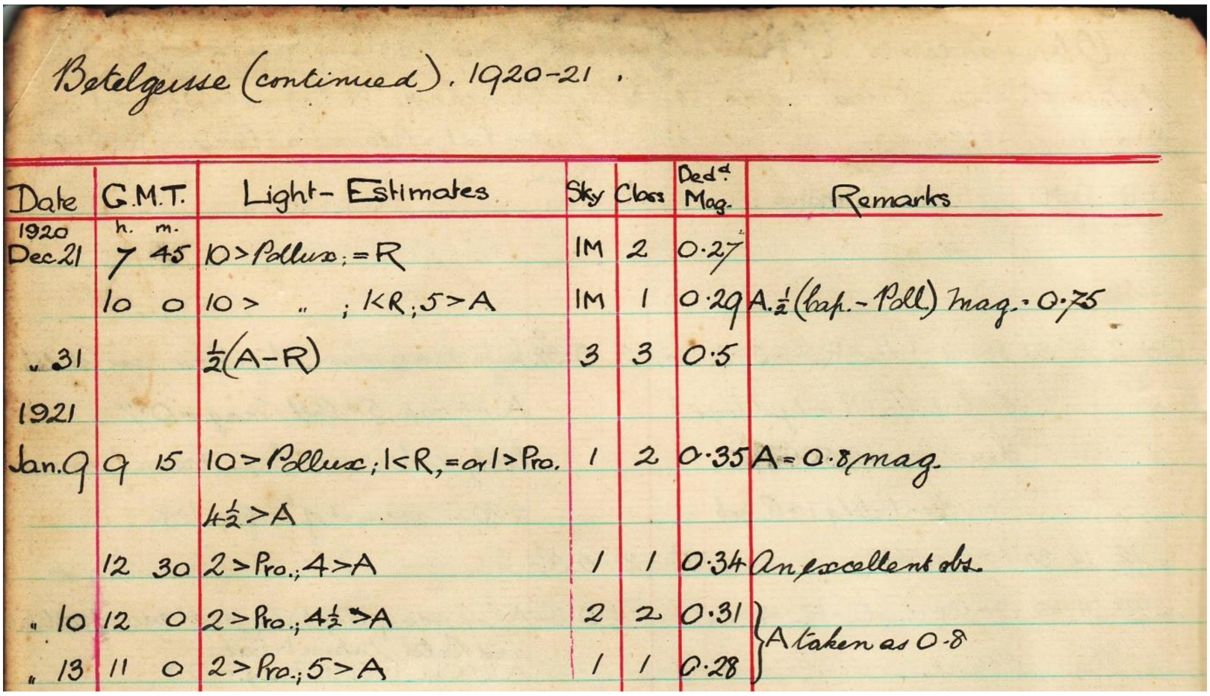
The Variable Star Observations of Alphonso King

Alex Pratt

Almost 100 years ago Howard Carter found great treasures that had lain undiscovered for thousands of years. Excavating Melvyn Taylor's extensive archive has also uncovered "wonderful things". A search through his bookshelves revealed a foolscap-size logbook entitled: -

It contains magnitude estimates of variable stars and observations of meteors made during the 1920s and early 1930s by Alphonso King (1882 January 17 - 1936 April 18) from Ashby, North Lincolnshire. He was an invaluable member of the BAA Meteor Section, being its chief computer. He painstakingly spent innumerable hours computing the true paths of meteors from dual-station visual observations and contributed reports to the Section's Memoirs. In King's obituary, Prentice writes "…the computation of a single accordance would take him about two hours *if the observations were favourable."* [1]

Alphonso King must have spent some time away from his meteor analyses to undertake the variable star observations which he recorded in his clear handwriting, such as the following estimates of Betelgeuse.

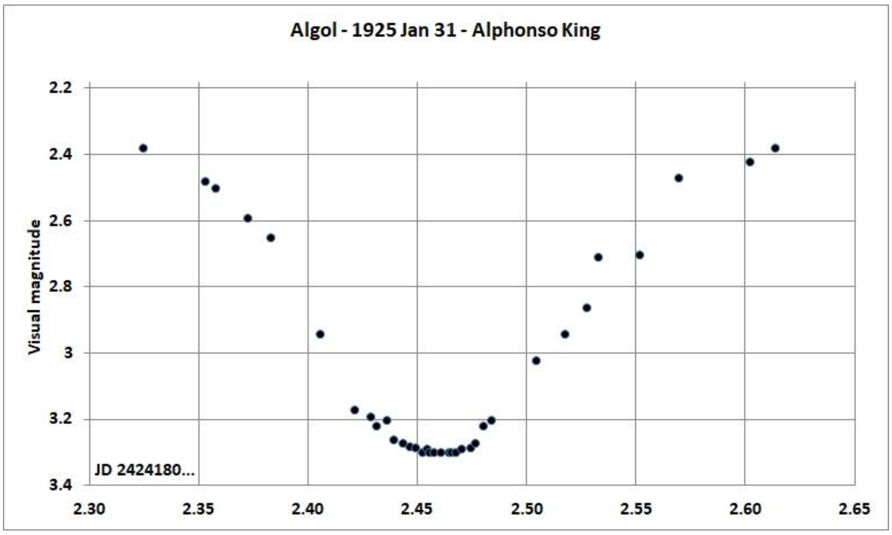


Betelgeuse (continued). 1920-21.

Date	G.M.T. h. m.	Light-Estimates	Sky	Class	Ded^d Mag.	Remarks
1920 Dec 21	7 45	10>Pollux; =R	1M	2	0·27	
	10 0	10> " ; 1<R; 5>A	1M	1	0·29	A. ½(Cap.-Poll) mag.-0·75
" 31		½(A-R)	3	3	0·5	
1921 Jan 9	9 15	10>Pollux; 1<R, =or 1>Pro. 4½>A	1	2	0·35	A=0·8 mag.
	12 30	2>Pro.; 4>A	1	1	0·34	An excellent obs.
" 10	12 0	2>Pro.; 4½>A	2	2	0·31	A taken as 0·8
" 13	11 0	2>Pro.; 5>A	1	1	0·28	

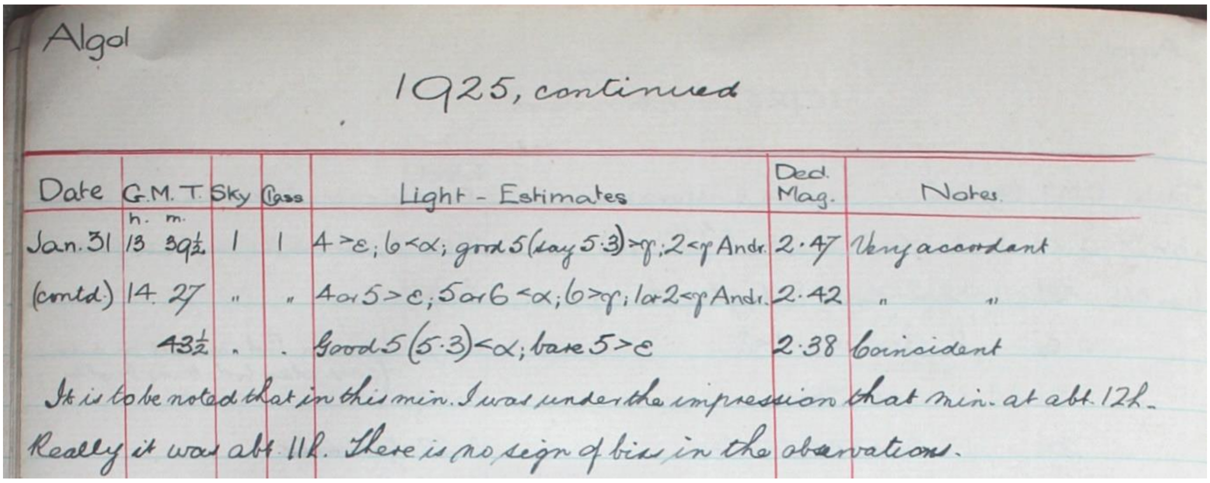
(His comparison stars were Aldebaran, Capella, Castor, Pollux, Procyon and Rigel). For his timings King compared his watch against a wireless time signal. He used the now obsolete GMAT system.

The VSS database holds only 173 of King's observations, from 1900 January - 1905 April, and from 1934 December - 1935 March. His log-book contains 1,499 unrecorded naked-eye estimates of stars such as Betelgeuse, delta Cephei, beta Lyrae, Algol, rho Persei, epsilon Aurigae and Mira, occasionally aided by a 'field-glass' or a 2-inch telescope.



In addition to his 27 estimates of Algol (beta Per) currently in the database (1900 January - 1902 February), he made a further 802 unrecorded measures of this eclipsing binary. Like many observers of this prototype EA system, King was sometimes only able to monitor its descending or ascending branch, or he was frustratingly thwarted by poor sky conditions during an otherwise favourable minimum. One of his best series is from the night of 1925 Jan 31 which I transcribed into a spreadsheet and produced the following light curve. [2]

It looks good, although we can see that he was over-observing the star, particularly around its minimum. He would often make estimates only a few minutes apart, which is not recommended practice! He was aware of the risk of introducing bias into his results, as he noted in his log…



Algol

1925, continued

Date	G.M.T. h. m.	Sky	Class	Light - Estimates	Ded. Mag.	Notes
Jan. 31	13 39½	1	1	4 > ε; 6 < α; good 5 (say 5·3) > γ; 2 < γ Andr.	2·47	Very accordant
(cntd.)	14 27	"	"	4 or 5 > ε; 5 or 6 < α; 6 > γ; 1 or 2 < γ Andr.	2·42	" "
	43½	"	"	Good 5 (5·3) < α; bare 5 > ε	2·38	Coincident

It is to be noted that in this min. I was under the impression that min. at abt. 12h. Really it was abt. 11h. There is no sign of bias in the observations.

He thought its minimum would be at 12 pm; it was actually predicted to occur at about 11 pm.

The BAA Handbook for 1925 [3] gives the approximate time of primary (geocentric) minimum at 22.9 hrs GMT. The light curve of King's observations suggests it occurred a little later, at 23.05 hrs (23 hrs 3 mins 15 sec, JD 2424182.46059, HJD 2424182.46182).[2],[4] The earliest estimates of beta Per in the VSS database are those by E. E. Markwick in 1891 through to H. R. Hanbridge in 1905, after which there's none until a single estimate by G. T. Buss in 1951, then another large gap until Tony Markham's observations in 1977. King's estimates from the 1920s and early 1930s will contribute data to this sparse era in the BAA's record of Algol's primary minima.[5]

I looked through Melvyn's observing notes for the document's provenance, but I couldn't find out how King's fascinating volume came into his possession. I photographed every page of the logbook and at the 2018 December BAA Christmas meeting it was handed to Richard McKim for safekeeping in the BAA Archive. The book isn't in good condition; it has almost separated from its cover and its frontispiece has suffered some (water?) damage, so Richard will arrange for it to be re-bound. My images of King's pages of VS observations will be submitted to the Section Director for adding to the VSS database.

References

[1] Prentice, J.P.M., 'Obituary – Alphonso King', *J. Brit. Astron. Assoc*., **46**(8), 301-302 (1936)

[2] BAA Computing Section – Julian Date converter http://britastro.org/computing/applets_jd.html

[3] BAA Handbook for 1925 (1924)

[4] BAA Computing Section – Heliocentric Julian Date converter http://britastro.org/computing/applets_dt.html

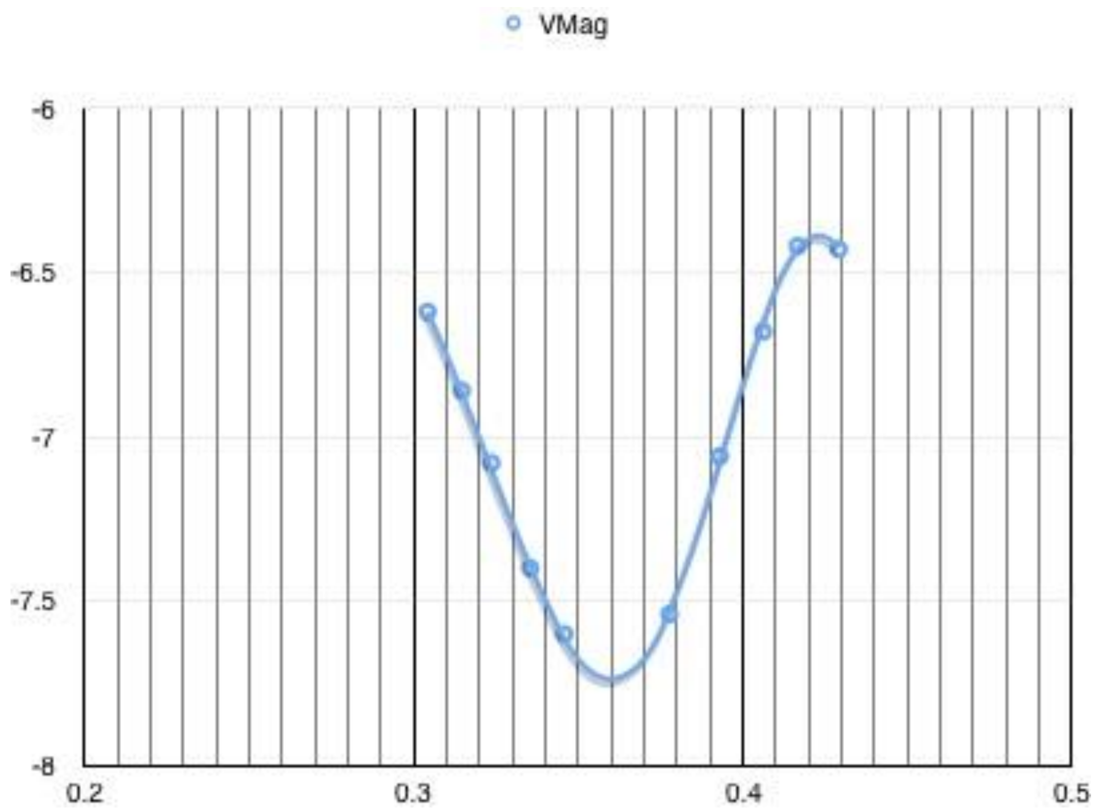
[5] The BAA Memoirs are a good source of observers' timings of primary minima of Algol, although not all their estimates can be found in the VSS database.

Eclipsing Binary News – May 2019

Des Loughney

RZ Cassiopeiae

I was able to observe much of the eclipse of RZ Cas on 4/3/19. Unfortunately, cloud obscured the primary minimum period for 40 minutes but I was able to make ten measurements (DSLR photometry), five on each side of the primary minimum which enabled an estimation of the time of mid eclipse to be made. Below is a diagram of the measurements. The vertical axis is magnitude. The horizontal axis is Julian Day 2458547. The light curve is drawn by my spreadsheet programme.



Using the bisected chord method primary mid eclipse was estimated to occur at 2458547.358 JD. This was converted into the HJD time of 2458547.3575. The Krakow website predicted mid-eclipse, based on the period 1.195252 days, to occur at 2458547.356868. There is very little difference between the observed time of mid eclipse compared with the predicted time of mid-eclipse - less than two minutes - within the margin of error. The current quoted period seems to be unchanged.
It was a pity that it was not possible to get more measurements near mid eclipse as that may have provided more data to use to find out whether the eclipse was full or partial (or had other features).

Accurate mass and radius determinations of a cool subdwarf in an eclipsing binary

See: <https://www.nature.com/articles/s41550-019-0746-7>

Abstract:

Cool subdwarfs are metal-poor low-mass stars that formed during the early stages of the evolution of our Galaxy. Because they are relatively rare in the vicinity of the Sun, we know of few cool subdwarfs in the solar neighbourhood, and none for which both the mass and the radius are accurately determined. This hampers our understanding of stars at the low-mass end of the main sequence. Here we report the discovery of SDSSJ235524.29+044855.7 as an eclipsing binary containing a cool subdwarf star, with a white dwarf companion. From the light curve and the radial-velocity curve of the binary we determine the mass and the radius of the cool subdwarf and we derive its effective temperature and luminosity by analysing its spectral energy distribution. Our results validate the theoretical relations between mass, radius, effective temperature and luminosity for low-mass, low-metallicity stars.

V448 Cygni

This eclipsing binary system belongs to the EB class. It is therefore in continuous eclipse and can be observed at any time. Its maximum is around 7.9 magnitude. The primary eclipse has a depth of about 0.8 magnitude and the secondary 0.4. The current period is 6.519709 days (Krakow). As a relatively bright system it has been of interest to our members. We supply monthly predictions on our website.

As a MNRAS paper (1) states:

“Both components of this binary are massive stars, thus making this system particularly important for our understanding of the star formation processes. The duration of the mass transfer process in the massive close binaries is very short and the mass transfer rate is very large giving rise to unusual physical conditions and chemical composition in such systems. Therefore, a good knowledge of the models of binaries like V448 Cygni is essential, and the determination of their parameters is both important and challenging.”

David Conner has observed this system and on his website at <https://davidsconner.weebly.com/v448-cygni.html>

where he has the diagram below (Figure 1). The phase diagram, based on measurements between 2013 and 2015 shows the classical features of an EB system. The phase diagram also shows near the maxima a collection of measurements that seem to illustrate ‘bright spots’.

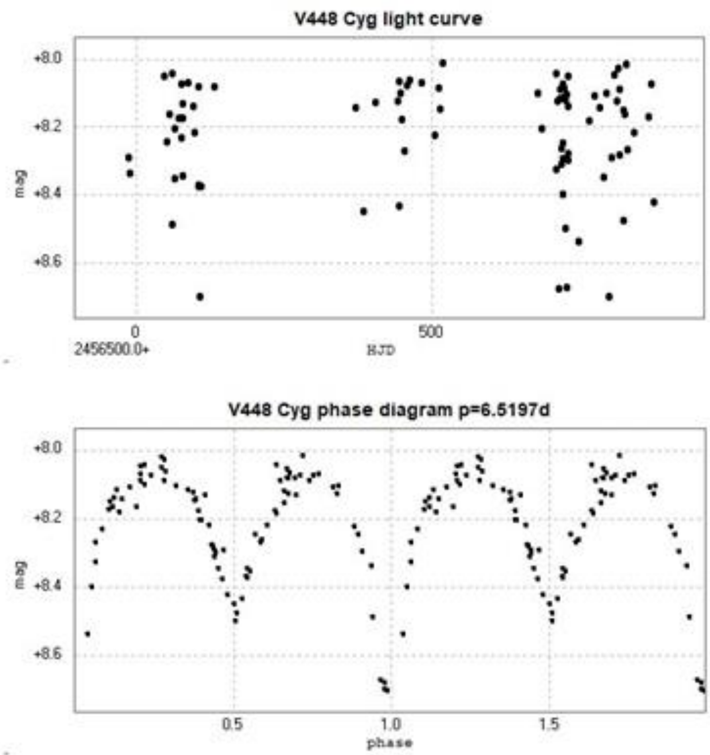


Figure 1: Light curve and phase diagram of the EB type eclipsing binary V448 Cyg, constructed from photometry of 86 unfiltered images taken with the Bradford Robotic Telescope cluster camera between 2013 July 7 and 2015 December 16.

The MNRAS paper suggests an explanation for these ‘bright spots’. It suggests that the system has an accretion disc around the secondary star. A gas stream is flowing from the massive donor primary star which falls on the accretion disc. The physics of the interaction produces the bright or hot spots.

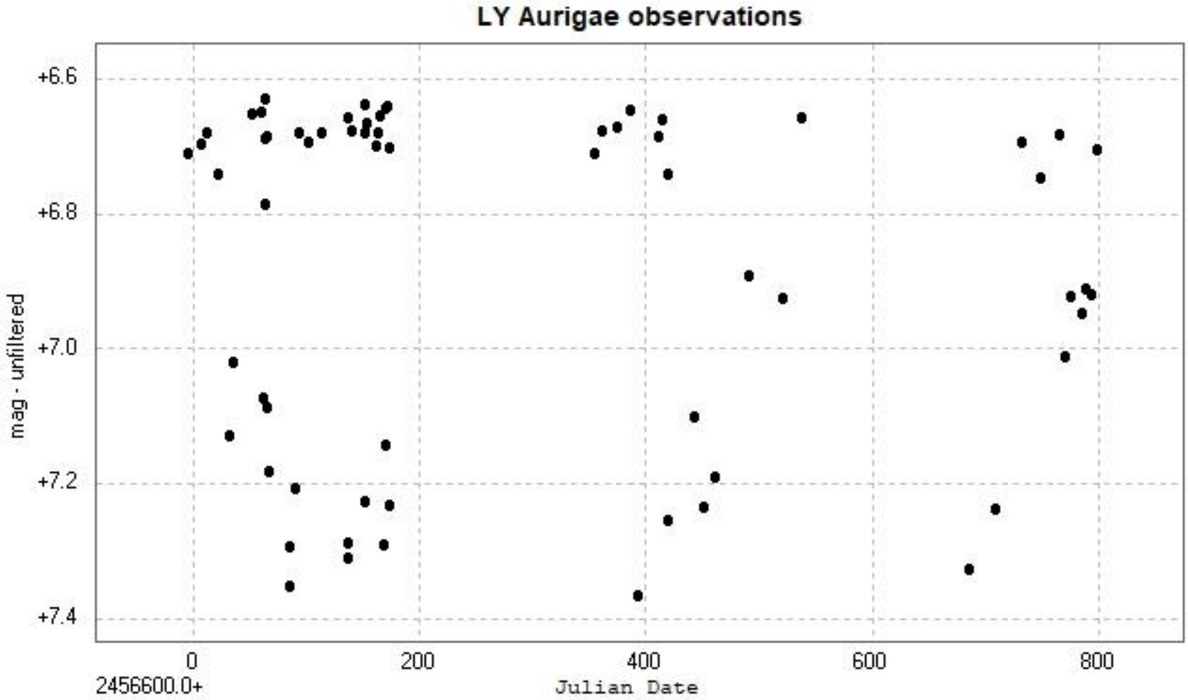
It is excellent that David Connors’ measurements have picked photometric information about the accretion disc and its associated hot spots. This is the sort of ongoing information that is called for in the (2009) paper. It seems to be unlikely that the hot spots could be picked up by visual observations but maybe by DSLR photometry. I intend to have a good look at this system in the autumn. Hopefully, David can repeat his measurements in 2019!

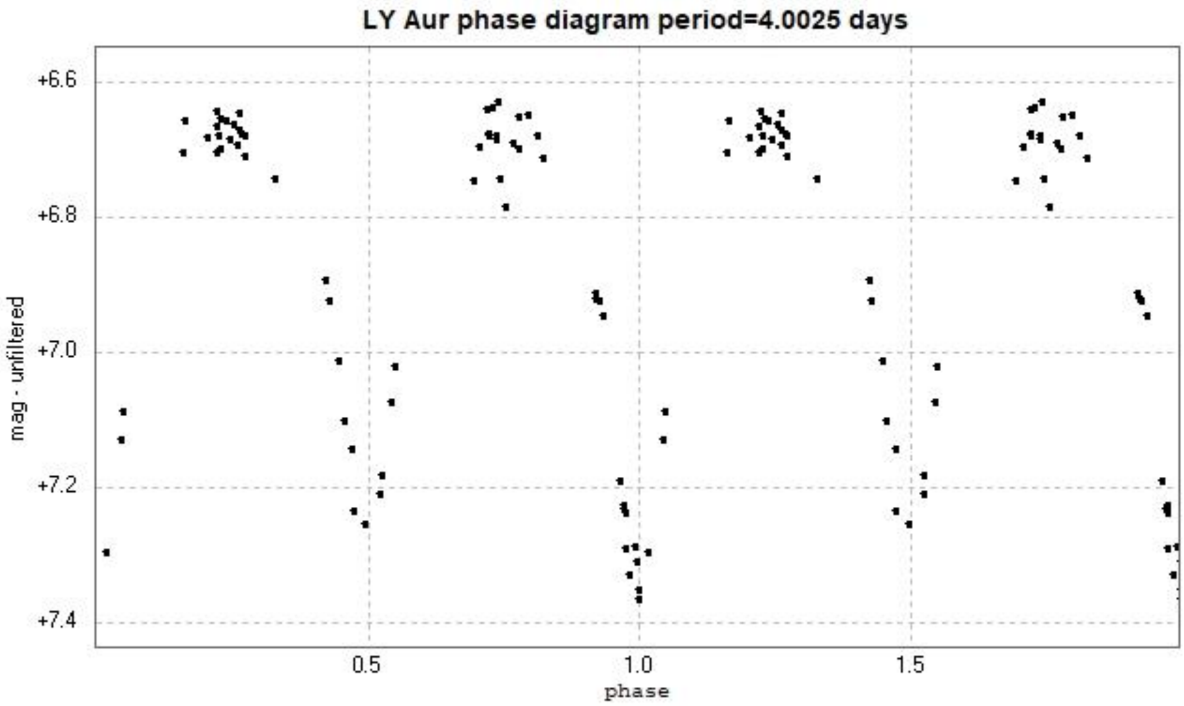
(1) Accretion disc in the massive V448 Cygni system
G. Djurašević I. Vince T. S. Khruzina E. Rovithis–Livaniou
Monthly Notices of the Royal Astronomical Society, Volume 396, Issue 3, 1 July 2009, Pages 1553–1558.

LY Aurigae

David Connor

The Eclipsing Binary News in Variable Star Section circular 179 (Des Loughney, March 2019) discussed the LY Aurigae system and suggested making observations of it. This system was one I included in my eclipsing binary project using the now decommissioned Bradford Robotic Telescope, when I requested images to be taken with the ‘Cluster Camera’, a 200mm focal length lens with a field of view of approximately 3 degrees square. Between 30th October 2013 and 10th January 2016 this system returned 64 unfiltered images of LY Aurigae. The following diagrams show the raw observations and the corresponding phase diagram plotted with a period of 4.0025 days.





The above observations were submitted to the BAAVSS data-base, and more information can be found here.

A date for your diary

BAA VSS Section Meeting

Saturday May 9th, 2020

The Humfrey Rooms,
10 Castilian Terrace,
Northampton NN1 1LD.

Further details in due course

Section Publications

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Charts for all stars on the BAAVSS observing programmes are freely available to download from the VSS Website www.britastro.org/vss

Contributing to the VSSC

Written articles on any aspect of variable star research or observing are welcomed for publication in this Circular. The article must be your own work and should not have appeared in any other publication. Acknowledgement for light curves, images and extracts of text must be included in your submission if they are not your own work! References should be applied where necessary.

Please make sure of your spelling before submitting to the editor. English (not American English) is used throughout this publication.

Articles can be submitted to the editor as text, RTF or MS Word formats. Light curves, images etc. may be submitted in any of the popular formats. Please make the font size for X & Y axes on light curves large enough to be easily read.

Deadlines for contributions are the 15th of the month preceding the month of publication. Contributions received after this date may be held over for future Circulars. Circulars will be available for download from the BAA and BAAVSS web pages on the 1st day of March, June, September and December.

Notes for readers: *All text bookmarks, www and e-mail links are active. Clicking on an image with a blue border will take you to a relevant image or text elsewhere in this Circular.*

Deadline for the next VSSC is August 15th, 2019

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