The British Astronomical Association

Variable Star Section Circular

No. 175 March 2018

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Contents

Cover image UV Per in outburst. 2017 Dec 20.914. iTelescope T7 *Nick Hewitt*

Joint BAA/AAVSO Meeting on Variable Stars

Warwick University

Saturday 7th & Sunday 8th July 2018

Following the last very successful joint meeting between the BAAVSS and the AAVSO at Cambridge in 2008, we are holding another joint meeting at Warwick University in the UK on 7-8 July 2018. This two-day meeting will include talks by

Prof Giovanna Tinetti (University College London)
Chemical composition of planets in our Galaxy
Prof Boris Gaensicke (University of Warwick)
Gaia: Transforming Stellar Astronomy
Prof Tom Marsh (University of Warwick)
AR Scorpii: a remarkable highly variable star discovered by amateur astronomers
Prof Christian Knigge (University of Southampton)
Cataclysmic Variables as Universal Accretion Laboratories
Dr Guillem Anglada Escude (Queen Mary, University of London)
Red Dots Initiative: science and opportunities in finding planets around the nearest red-dwarfs
Dr Dirk Froebrich (University of Kent)
The HOYS-CAPS Citizen Science Project
Francois Teyssier (Astronomical Ring for Access to Spectroscopy)
Observing Symbiotic Stars
Francois Cochard (Shelyak Instruments)
Starting in Spectroscopy

plus talks by Mike Poxon, Andrew Wilson, John Toone, David Boyd, Robin Leadbeater, Andrew Smith Josch Hambsch and many others.

Opportunities to present short talks (15 or 20 min) are still available.
If you would like to give a talk, please send your proposed title and a short abstract (<250 words) to Roger Pickard at roger.pickard@sky.com
and the AAVSO with the subject "abstract for BAA/AAVSO meeting"
More information about the meeting and online registration are available at
https://britastro.org/summer2018

From the Director

Roger Pickard

Data

You will read elsewhere in the Circular Alex Pratt's note on updating the database with old observations that have been found in Melvyn's files (which, incidentally also includes a few of my own!). However, this is putting a strain on the Section's resources in that we only have a limited number of "data inputters" and they already have data to input from those observers who, for whatever reason, are unable to input their own data each year. Therefore, could I appeal for help in inputting these "lost" observations from Melvyn's files? It is quite straightforward as Alex has scanned the observations into PDF format and all I need do is send you a few of these at a time.

SPRING MIRA'S

M = Max, m = min.

R And	*m*=Feb/Mar
W And	*M*=Feb/Mar
R Aql	*m*=Apr
UV Aur	*m*=Apr/May
X Cam	*m*=Apr/May
SU Cnc	*m*=May/Jun
U CVn	*m*=Mar
RT CVn	*M*=May
R Com	*m*=Mar/Apr
S CrB	*m*=Apr
W CrB	*m*=Mar/Apr
V CrB	*m*=May
R Cyg	*M*=May
S Cyg	*m*=Mar
V Cyg	*M*=Apr/May
SS Her	*M*=May
	m=Mar/Apr
R Hya	*m*=Apr
SU Lac	*m*=May/Jun
RS Leo	*m*=Apr/May
W Lyn	*M*=May
X Lyn	*M*=May/Jun
X Oph	*M*=Mar/Apr
U Ori	*M*=Apr/May

Source BAA Handbook

Melvyn's archive - AAVSO Journals, GCVS, etc

Alex has also reported that Melvyn's archive contains the following documents that might be of interest to members of the VSS: -

AAVSO Journals from 1970s-2000s
75th anniversary edition of the AAVSO Journal (1986)
Education of American Women Astronomers before 1960
Manual for Visual Observing of Variable Stars (2001 March)
European AAVSO Brussels 1990 July 24-28 info folder
Light Curves of Variable Stars for 1988-1992
Hungarian Astronomical Association - Laszlo Kiss
The Variable Star Observer - Newsletter - Tristram Brelstaff 1992
Reports of BSS (Binocular Sky Society) 1967/68, '69
Pro-Am report 1988
IUAA (International Union of Amateur Astronomers) info - 1988
Publications of USNO 1982 Vol XXI Photoelectric Catalogue of Stars
Stars in galactic cluster fields
2nd Cat. Trigonometric parallaxes of faint stars
Zodiacal Catalogue Vol X part II
Astrophysical Journal reprints

Please let me know if you would be interested in any of these documents and I'll put you in touch with Alex, so you can arrange collection.

And finally. You will find details of the forthcoming BAA-AAVSO meeting elsewhere in this Circular, but if you would like to give a presentation (typically 15 or 20-minute time slots) then please advise the Director. Please also include a title and be aware that I shall also be requesting a short abstract before 8th June 2018.

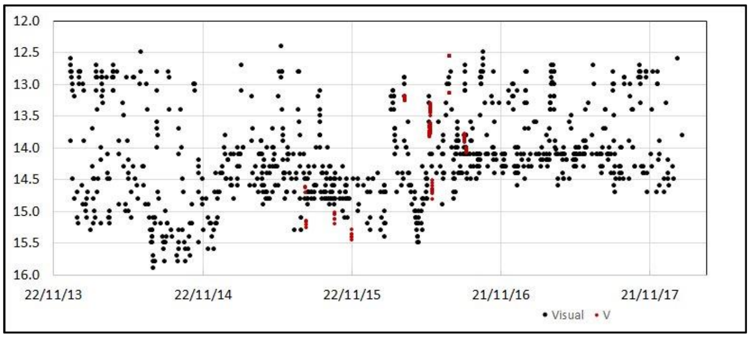
CV & E News

Gary Poyner

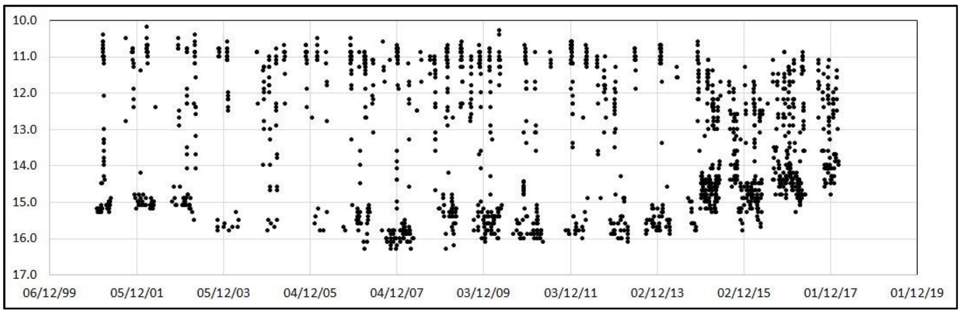
The first outburst of the UGSU star UV Per since June 2016 was detected on 2017 Dec 18.48 UT by Tsuneo Horie (Kanagawa, Japan) at visual magnitude 12.4 (40cm SCT) and announced on Vsnet & CVnet. The outburst proved to be normal, with UV Per returning to minimum five days later on Dec 23rd at 17.5V. The last Superoutburst was observed in November 2014, with the supercycle being in excess of 850d. Our cover picture shows an image taken by Nick Hewitt of UV Per in outburst on Dec 20.9UT at magnitude 13.9CV.

QY Per - another long period UGSU star, was detected in outburst on Jan 10.802 at 15.3 vis. by Tim Withers, and is the first outburst seen since the superoutburst of Nov. 2015. This normal outburst was quickly over with QY Per returning to quiescence by Jan 14 at 19.3CV.

The two UG stars AB Dra and SS Aur continue their anomalous behaviour with bright minimum and irregular outburst intervals. AB Dra has not been recorded below magnitude 15.0 at minimum since mid-2016, with its current minimum level around 14.5 mean and very often brighter. The effect is very obvious from the BAAVSS light curve shown left. Similar behaviour occurred for most of 2015 before 'normality' resumed in early January 2016. VSX now classifies AB Dra as type UG, whereas previously the classification was UGZ, despite standstills having never being observed. This current behaviour could be regarded as standstill activity, albeit at an unusually faint level (one might expect a standstill to occur in the mid 13's). Certainly, observers need to keep a close eye on AB Dra, which fortuitously is circumpolar from the UK.

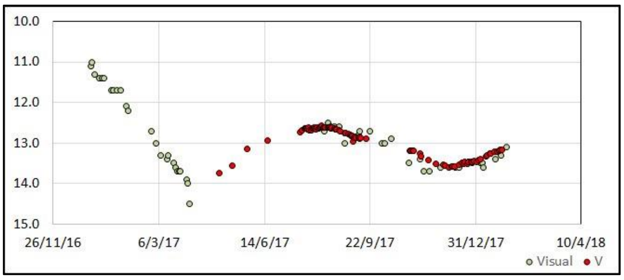


SS Aur has been showing increasingly unusual behaviour since early 2014. The BAAVSS light curve below shows how the minimum level has changed since 2003 from ~15.0 mean to 16.0 or below for a decade. Since 2013 the mean minimum level has risen from 14.9 to 14.2 with the outburst frequency also increasing from 49d mean in 2016 to 37d mean in 2017/18 with a decreased amplitude from ~5.5 magnitudes to ~3.5 magnitudes of course due to the high minimum state. If you're an observer with a 20-25cm telescope, this is a good time to catch SS Aur at minimum, and certainly a plea should be made to all observers to monitor both of these objects as closely as possible for the foreseeable future.



Of the twelve RCB stars on the CV&E programme, five are currently 'active'. After 10.5 years (~3,800 days) R CrB still refuses to return to its normal levels. There has been a very slow rise during the winter period from 7.0 to 6.5 mean by February 2018, but will this long active period finally end in 2018? Observe at every opportunity!

Since it faded from maximum magnitude 11.0 to 13.5 in Jan-Mar 2017, DY Per has been showing an almost periodic variation from 12.5V-13.5V over the past 11 months, which is somewhat unusual. Close inspection of intermediate depth fades (between magnitude 13-14) dating back to 1992 does not reveal similar variations. Observers are asked to closely monitor DY Per during the Spring period for as long as possible to see if this continues.



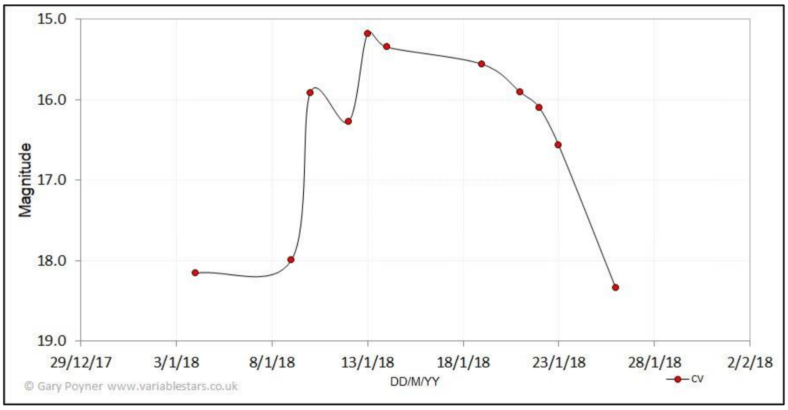
DY Per Jan 17-Feb 18. Vis.& V. *Poyner*

Following its decline to a deep minimum of 18.0V in May 2017, AO Her recovered to 14.8V by mid-July before again fading to an even deeper 18.6V in October 2017. A slow recovery has begun with AO Her rising to 16.5V in February 2018. AO Her is a recent member of the RCB family, being spectroscopically confirmed as an RCB type as recently as 2013. Maximum magnitude is 11.0-12.0V. Another (fairly) recent addition to the RCB family, V742 Lyr (NSV 11154) is also extremely faint at present, reaching magnitude 18.95V in October 2017 following the start of the fade in August from maximum magnitude 12.0. Recent data suggest that the star remains at minimum around magnitude 18.0V in February.

SU Tau – a very familiar RCB star with BAAVSS observers, is slowly recovering from a lengthy minimum which begun in November 2011. It reached magnitude 16.6CV in January 2012 before recovering to 11.6 in March of that year. By early April a new fade begun, taking SU Tau to a minimum of ~18.0V in August 2012 where it remained until the current recovery began in December 2015. It's mid-February as I write, and SU Tau is back to magnitude 13.0. SU Tau has the largest amplitude of all known RCB stars – 11 magnitudes!

And finally. I suspect that most of us observe stars which are not on any of the BAAVSS observing programmes, and if you're an observer of CV's then you really are spoiled for choice. Here I'm highlighting one of many such stars I have on my own observing programme. If you have any interesting objects which might not be well known, then please share them with us through the VSSC!

HV Aur is a UGSU system with a P_{orb} of 118.2m and an amplitude of 15.0V-<19.0V. Outbursts occur roughly every 4 months. I've been monitoring it visually and with remote CCD since 2004 and have picked up a number of normal and superoutbursts during that time. In January 2018 I had a good run of clear nights with the OU COAST telescope and fortuitously images of HV Aur were returned on each night. A normal outburst was detected on Jan 10.14UT at 15.9CV and quickly faded to 16.3CV two days later on Jan 12.12UT. Twenty-four hours later on Jan 13.08UT HV Aur had risen to magnitude 15.2CV and had obviously entered a superoutburst. The light curve above shows the classic early slow decline followed by a steeper drop after 10 days had elapsed. I've seen normal outbursts trigger superoutbursts in a number of stars over the years, but this was the first time I had seen it in HV Aur. A check through the AAVSO IDB showed no similar event occurring back to the first data submitted in 2002. A good reason to continue to monitor this neglected CV.



Back to contents

Project Melvyn – Raiders of the lost archive *Alex Pratt*

Melvyn Taylor, one of the Section's most prolific visual observers, passed away on 12th August 2017. Since last autumn, Len Entwisle and I have been helping his family to work through his large collection of notebooks, observing logs, astronomy books and observing equipment.

Melvyn made more than 90,000 variable star estimates, although only 36,394 were logged in the VSS database. His family kindly gave me access to his laptop computer and I found a number of visual report spreadsheet files containing nearly 15,000 of his unrecorded VS estimates for the years 2009-2015. Tracie Heywood volunteered to convert them to the latest format, to check each entry and upload them to the database. As of early February 2018, Tracie has processed 12,000 of these observations, bringing Melvyn's tally to over 48,000.

Len and I also found numerous card folders containing observers' visual report forms of the binocular programme stars RS And, RX Boo, V CVn, DM Cep, U and EU Del, BN, BQ, BU, NQ, TU, TV and WY Gem, ST Her, RV and SX Mon, Z UMa, RR UMi plus several other stars, for the 1970s, 80s and early 90s. The files included Melvyn's annual summaries of each star's observations, with tracing paper plots of their variations in brightness, but checks of the database confirmed that many of these observations hadn't been uploaded, explaining the gaps in the VSS light curves for those years.

Where to start! I chose the V CVn folder and identified which observations weren't in the database and scanned each observer's set of unrecorded forms to a PDF file. If an observer was a currently active contributor to the database (and I knew their e-mail address) I sent them the PDF asking them to add their dormant data. In other cases, the PDFs were e-mailed to the Section Director who either forwarded them to their owners or allocated them to volunteers for uploading.

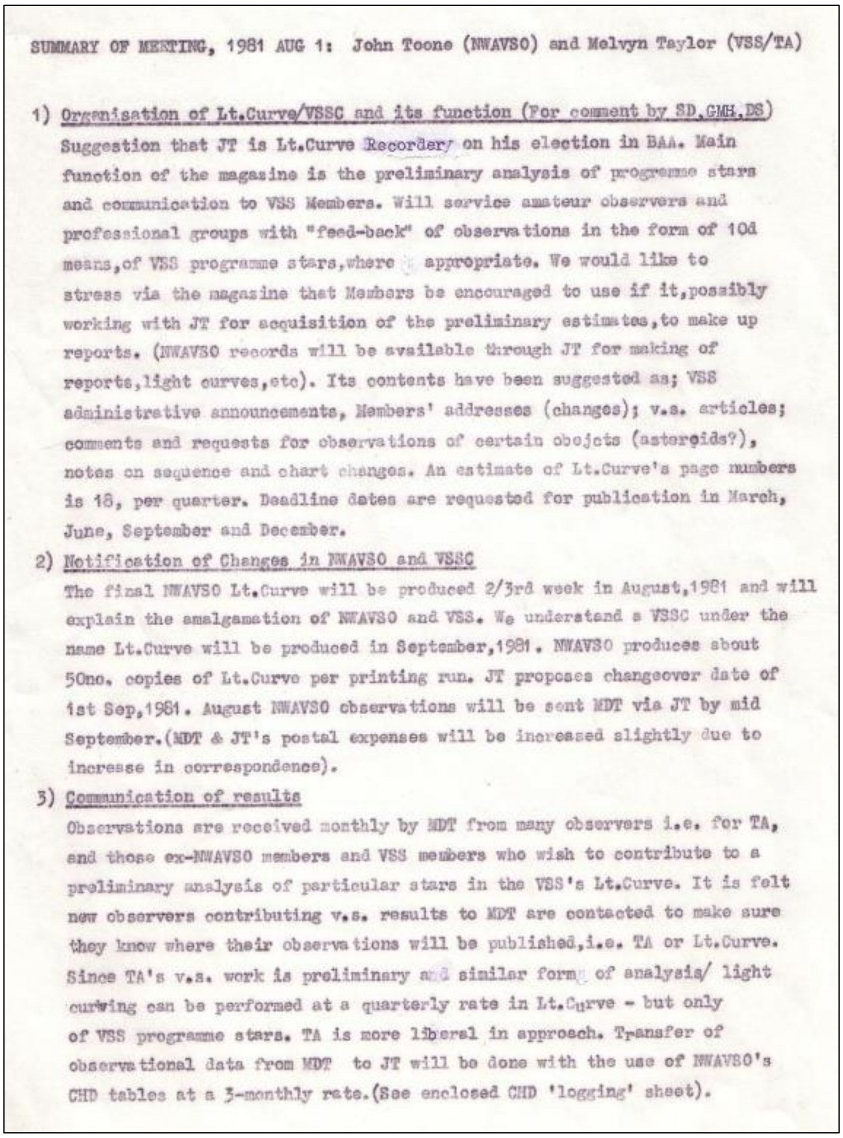
I've now finished working through the V CVn, ST Her and Z UMa folders. This recovered 6,104 observations on 585 report forms submitted by 89 observers. The 5 most prolific contributors were: Ian Middlemist (1,086), Shaun Albrighton (430), Melvyn Taylor (418), Bill Worraker (408) and Rhona Fraser (323).

Thanks to Melvyn's family we have found thousands of unrecorded visual estimates, so this year should see steady progress as the Section's hard-working volunteers add these 'lost' observations to the VSS database. Updates on Project Melvyn will appear in future Circulars.

Please check if you have any unrecorded observations in your possession and upload them to the database. The Section Director and Database Secretary can provide guidance, if required.

The amalgamation of the NWAVSO & BAAVSS *John Toone*

My initial involvement in variable star work in 1975-1978 was through the North Western Association of Variable Star Observers (NWAVSO) headed up by Colin Henshaw. Based in Manchester it was literally on my doorstep and in January 1979 I was elected to Council and got involved in the running of the Association becoming its Recorder in 1980. Like the Astronomer (TA) the NWAVSO promoted rapid feedback to observers but went further with preliminary analysis of data whilst still encouraging the submission of data to the BAA VSS for long term analysis. The principle publication of the NWAVSO was its journal 'Light Curve' (name proposed by Ian Middlemist) that was produced six times a year. Contained within Light Curve were 10 day means and preliminary light curves of the programme stars. The NWAVSO grew beyond a regional group and quickly became international in nature with a particularly large following in Eastern Europe. However, echoing what happened with the Liverpool Astronomical Society in the 1880's, the rapid expansion of the NWAVSO proved to be unsustainable without the support of a national organisation and in 1981 the NWAVSO was forced to amalgamate with the BAA VSS.


SUMMARY OF MEETING, 1981 AUG 1: John Toone (NWAVSO) and Melvyn Taylor (VSS/TA)

1) Organisation of Lt.Curve/VSSC and its function (For comment by SD,GMH,DS)
Suggestion that JT is Lt.Curve Recorder on his election in BAA. Main function of the magasine is the preliminary analysis of programme stars and communication to VSS Members. Will service amateur observers and professional groups with "feed-back" of observations in the form of 10d means,of VSS programme stars,where appropriate. We would like to stress via the magazine that Members be encouraged to use if it,possibly working with JT for acquisition of the preliminary estimates,to make up reports. (NWAVSO records will be available through JT for making of reports,light curves,etc). Its contents have been suggested as; VSS administrative announcements, Members' addresses (changes); v.s. articles; comments and requests for observations of certain obojcts (asteroids?), notes on sequence and chart changes. An estimate of Lt.Curve's page numbers is 18, per quarter. Deadline dates are requested for publication in March, June, September and December.

2) Notification of Changes in NWAVSO and VSSC
The final NWAVSO Lt.Curve will be produced 2/3rd week in August,1981 and will explain the amalgamation of NWAVSO and VSS. We understand a VSSC under the name Lt.Curve will be produced in September,1981. NWAVSO produces about 50no. copies of Lt.Curve per printing run. JT proposes changeover date of 1st Sep,1981. August NWAVSO observations will be sent MDT via JT by mid September.(MDT & JT's postal expenses will be increased slightly due to increase in correspondence).

3) Communication of results
Observations are received monthly by MDT from many observers i.e. for TA, and those ex-NWAVSO members and VSS members who wish to contribute to a preliminary analysis of particular stars in the VSS's Lt.Curve. It is felt new observers contributing v.s. results to MDT are contacted to make sure they know where their observations will be published,i.e. TA or Lt.Curve. Since TA's v.s. work is preliminary and similar form of analysis/ light curving can be performed at a quarterly rate in Lt.Curve - but only of VSS programme stars. TA is more liberal in approach. Transfer of observational data from MDT to JT will be done with the use of NWAVSO's CHD tables at a 3-monthly rate.(See enclosed CHD 'logging' sheet).

Figure 1: Summary notes of the meeting held in Wakefield on 1st August 1981

Shaun Albrighton also got involved with the NWAVSO whilst studying at Salford University in 1979-1982 and when not studying at the weekends Shaun and I often met to discuss astronomy related matters. In early 1980 Shaun suggested we go over to Yorkshire to meet Melvyn Taylor and my diary has the following entry for 8th March 1980:

"I caught a bus to Manchester and along with Shaun Albrighton went by train to Wakefield via Huddersfield. I met Melvyn Taylor for the first time. At his house we discussed flare stars and copied out VS charts. We had a pint at the local before travelling back home".

Thereafter I was in regular contact with Melvyn particularly on the topics of charts, sequences & data handling and Melvyn was to undertake an important part in the NWAVSO/BAA VSS merger that was looming. The decision to amalgamate the two groups was taken by Colin Henshaw in consultation with Doug Saw (BAA VSS Director) in mid-1981. I was then tasked together with Melvyn to work out the details of its practical implementation particularly with respect to data handling & reporting via the VSS Circulars adopting the title 'Light Curve' from the NWAVSO Journal. In this respect my diary entry for 1st August 1981 records:

"I drove to Melvyn Taylor's house in Wakefield taking 75 minutes. We discussed at length the problems of recording observations and came to an arrangement over logging observations for the BAA".

Melvyn typed up summary notes of the meeting which are reproduced as Figure 1. The key output from the meeting was that the VSS Circular/Light Curve would act as intermediate feed-back to observers (10 day means & preliminary light curves) between TA (monthly data lists) and the BAA Journal (long term analysis reports). In addition, the amalgamation date was fixed at 1st September 1981 and it was proposed that I became a VSS officer once elected to the BAA.

CHD	DATE (1985)	JULIAN					
	JAN 1	2446067					
	JAN 2	2446068					
	JAN 3	2446069					
407	JAN 4	2446070					
	JAN 5	2446071					
	JAN 6	2446072					
	JAN 7	2446073					
	JAN 8	2446074					
	JAN 9	2446075					
	JAN 10	2446076					
	JAN 11	2446077					
	JAN 12	2446078					
	JAN 13	2446079					
408	JAN 14	2446080					
	JAN 15	2446081					
	JAN 16	2446082					
	JAN 17	2446083					
	JAN 18	2446084					
	JAN 19	2446085					
	JAN 20	2446086					
	JAN 21	2446087					
	JAN 22	2446088					
	JAN 23	2446089					
409	JAN 24	2446090					
	JAN 25	2446091					
	JAN 26	2446092					
	JAN 27	2446093					
	JAN 28	2446094					
	JAN 29	2446095					
	JAN 30	2446096					
	JAN 31	2446097					

Figure. 2. The CHD logging sheet referenced in the summary meeting notes that was used by the NWAVSO to compile 10 day means.

Subsequently the following happened:

1. The title of 'Light Curve' was adopted by the VSS Circular from No 47 (September 1981) to No 64 (August 1986).

2. The 10 day means listing was dropped and never appeared in the VSS Circular.

3. Preliminary light curves were included in VSS Circular No 49 (March 1982) and have been a regular feature ever since.

4. AGN's from the NWAVSO programme were added to the VSS Main Programme and the BAA VSS has become a valuable source of photometric data on AGN's.

5. I was elected to the BAA on 27th January 1982 and became a VSS officer on that date.

Looking back at this today I am of the opinion that the NWAVSO served a useful purpose in that the amalgamation refreshed the BAA VSS and that subsequently the VSS Circulars have indeed filled the gap between the preliminary monthly TA reports and the VSS reports & papers published within the BAA journal. I am also of the opinion that Melvyn Taylor played a key facilitating role in this respect.

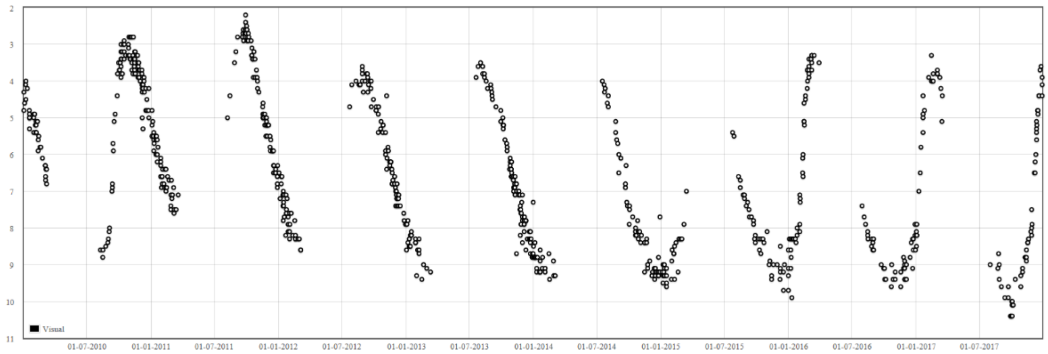
Mira variables with the hump

Shaun Albrighton

LPV or Mira variables have formed part of the Variable Star Sections programme since its formation. Over recent years however their study has waned in favour of the more dramatic Cataclysmic Variables. Despite this, analysis of Mira variables has raised some interesting results, including variations in period and complexity of the light curve.

When we examine the light curves for the majority of Mira variables, a smooth curve, admittedly with variations in max/min magnitude is observed (see light curve for omicron Cet below).

Light Curve for OMICRON CET



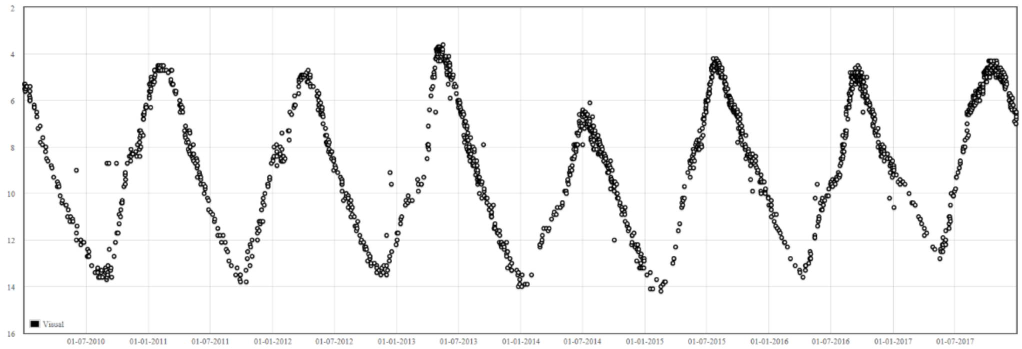
Symbol Key: **Crosses** = Negative observation, **Triangle** = Brighter than, Otherwise: **Circle** = Visual, **Diamond** = CCD, **Square** = Everything else

Contributors: S W Albrighton, B J Beesley, R C Dryden, N A Foster, R B I Fraser, M J Gainsford, K Griffiths, T L Heywood, M K Kidger, B MacDonald, B MacDonald, T Markham, J Meacham, D Scanlan, J D Shanklin, G Stefanopoulos, M D Taylor, J Thorpe, J Toone, T Vale

This graph is built using flot

In contrast some Miras have ever more complex light curves, displaying a standstill or hump. These most often occur on the ascending branch and is a point where the slope changes making it look as if the brightening (or dimming in the case of the descending branch) stalls for a period of time. This phenomenon may be related to those stars which show a double maximum. In addition, whilst some stars exhibit this behaviour during every cycle, others may only do so less frequently. Below is a light curve for chi Cyg (2010-2018), which reveals not only variations in max/min magnitude but also changes in position of the hump on the ascending branch. Of particular note is the most recent cycle, where following a very bright minimum we have witnessed the brightest hump recorded, at around mag 6.0.

Light Curve for CHI CYG



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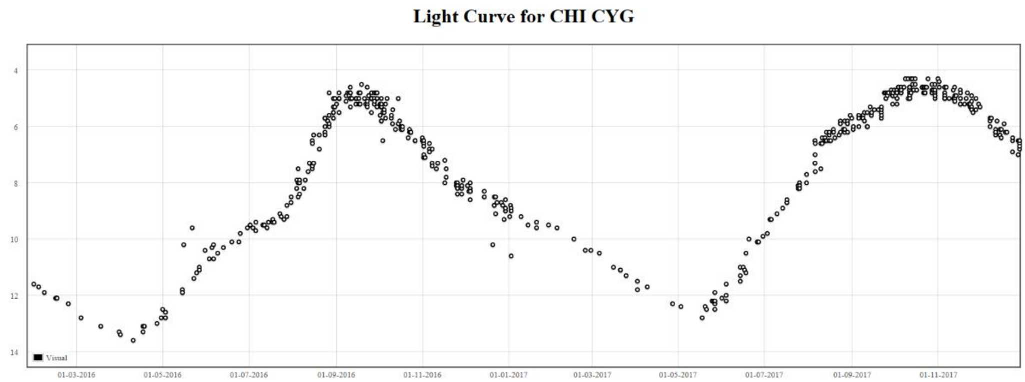
Contributors: P G Abel, S W Albrighton, C M Allen, B J Beesley, P Bishop, L K Brundle, R C Dryden, N A Foster, K Griffiths, T L Heywood, V Hull, T Jones, M K Kidger, B MacDonald, C Mann, T Markham, J Meacham, P Mulligan, R A H Paterson, R Pearce, G Poyner, E W Sawyer, D Scanlan, J D Shanklin, G Stefanopoulos, M D Taylor, J Toone, T Vale, N White, A J Wilson

This graph is built using flot

The light curve shown below for chi Cyg shows in closer detail how the bright hump on the ascending branch of the 2017 max led to a much broader maximum than is normally recorded



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

Contributors: P G Abel, S W Albrighton, C M Allen, B J Beesley, P Bishop, L K Brundle, R C Dryden, N A Foster, K Griffiths, T L Heywood, V Hull, T Jones, M K Kidger, B MacDonald, C Mann, T Markham, J Meacham, P Mulligan, R A H Paterson, R Pearce, G Poyner, E W Sawyer, D Scanlan, J D Shanklin, G Stefanopoulos, M D Taylor, J Toone, T Vale, N White, A J Wilson

This graph is built using flot

A paper in 1999, by N. D. Melikan, ‘Classification of the light curves of Mira variables’ [1], found:

a) A weak or non-existent correlation between period and spectrum.
b) Periods for stars with complex light curves peaked between 350 and 400 days, compared to those with simpler light curves of 250-300 days.
c) Absolute magnitudes are higher for complex Mira variables.
d) Polarisation occurs in approximately 50% of complex stars, double that of simpler stars.

In a study of T Cephei by Marsukova (2000) [2], showed that for this star the stable state appeared to be the minimum, with the appearance of the hump being related to the brightness of this stable state. In addition, there appears to be correlation between the hump and amplitude.

As a project, I encourage observers to add some Mira variables displaying complex light curves (see table below) to their programme. The AAVSO are encouraging their observers to undertake a similar project. By following these stars over a period of decades it may help us to understand how these stars evolve over time. Indeed, some astronomers suggest that all Mira variables will display more complex light curves at some point in their evolution.

Star	**RA(2000)Dec**		**Range**		**Period**	**Chart**	**Comments**
R Aqr	23 44	-15 17	5.2	12.40	387	096.01	Dual Maximum?
R Aur	05 17	+53 35	6.70	13.90	457.51	AAVSO	Hump Rising Curve
V Cam	06 03	+74 30	7.70	16.00	522.45	027.01	Hump Rising Curve
S Cas	01 19	+72 37	7.90	16.10	612.43	054.02	Hump Rising Curve
T Cas	00 23	+55 48	6.90	13.00	444.83	067.02	Dual Maximum
S Cep	21 35	+78 37	7.40	12.90	486.84	AAVSO	Moving Hump
T Cep	21 10	+68 29	5.20	11.30	388.14	338.01	Hump Rising Curve
S CrB	15 21	+31 22	5.80	14.10	360.26	043.02	Hump Rising Curve
Chi Cyg	19 51	+32 55	3.30	14.20	408.05	045.02	Hump Rising Curve
S Cyg	20 06	+57 59	9.30	17.00	322.93	032.01	No events recently
RU Her	16 10	+25 04	6.70	14.30	440.8	060.02	Hump Rising Curve
R Hya	13 30	-23 17	3.50	10.90	380	049.03	Hump Rising Curve
R Lyn	07 01	+55 20	7.20	14.30	365.5	AAVSO	Hump Rising Curve
U Ori	05 55	+20 11	4.80	13.00	377	059.02	Hump Rising Curve
R Peg	23 07	+10 33	6.90	13.80	378.1	AAVSO	Hump Rising Curve
S UMi	15 30	+78 38	7.50	<13.2	331	AAVSO	Hump Rising Curve

Of particular interest are:

- Magnitude and date of maximum.
- Magnitude and date of minimum (often under observed)
- Magnitude and date at start of hump
- Duration of hump

Recording this data will enable us to ascertain if there is any relation between the position of, or duration of the hump and magnitude at maximum and minimum or amplitude.

References

1: Melikian, N. 1999 Astrophysics 42:408. Classification of the light curves of Mira variables.
2: Unusual variations in the Mira star T Cephei, Vladislava T. Marakova; Ivan L. Andronov – Department of Astronomy, Odessa State University. Taken from The Impact of Large-Scale Surveys on Pulsating Star Research, A.S.P Conference Series Vol 203, 2000.

RS Per and SRc variables

Geoff Chaplin

RS Per is a semi-regular variable of spectral type M4 with a small magnitude range (the most famous such stars being Betelgeuse and mu Cep [the "garnet star"]). The BAA [1] quotes a magnitude range of 7.8-9.0V and the AAVSO [2] quotes a period of 245 days, while Kiss [3] identify a much longer period of 4500+/-1500 days. Such variables pose a severe challenge to the visual observer because of the Purkinje effect and the narrow range of variation. There are instances in the BAA database where two experienced observers (with more than 200 observations of RS Per each) may differ by as much as a magnitude in their estimate of the brightness of the star. Nevertheless, individual observer bias tends to be constant so even though the actual magnitude may be incorrect changes over short time periods tend to move in parallel. Tests suggest that, despite the Purkinje effect, more than 99% of the time experienced visual observers can track magnitude changes to better than 0.2. However, the large magnitude differences between observers, and some large short-term changes, could also be consistent with occasional rapid variation in magnitude.

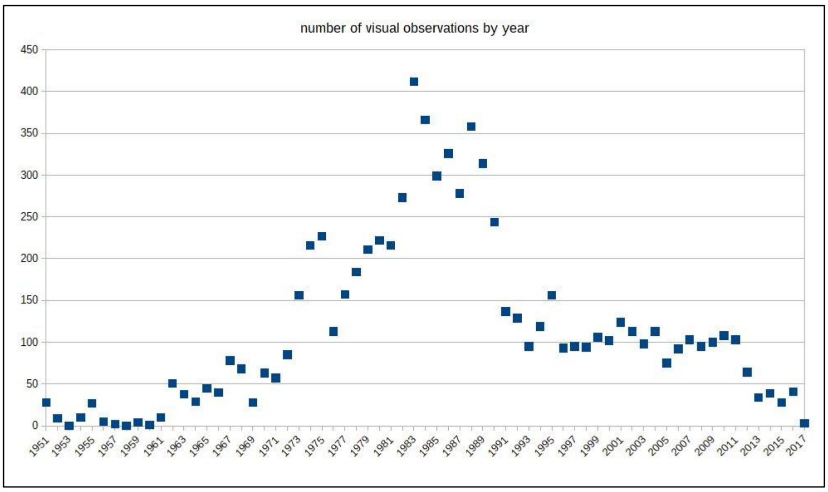


Figure 1

It is unfortunate that RS Per has lost some of its attraction for observers. Figure 1 shows the frequency of visual observations in the AAVSO database (of which the majority is contributed by BAA members). Unsurprisingly analysis is easier and most informative in the period 1976-1993 – ideally 200 or more visual observations a year are needed.

Figures 2 and 3 illustrate the data and show a long-term 2800 day and a short-term 470-day cycle. The data used is from experienced observers (more than 200 observations of RS Per each) and is after adjustment for individual bias. To illustrate the data more clearly a 13-day centred moving average is shown.

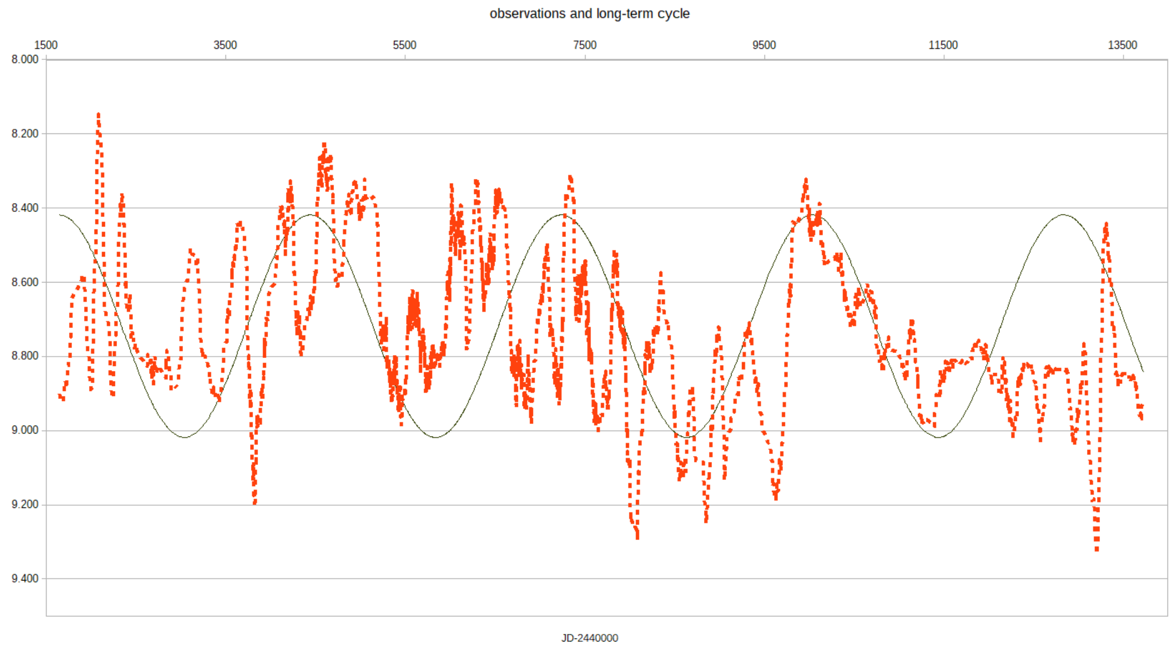


Figure 2

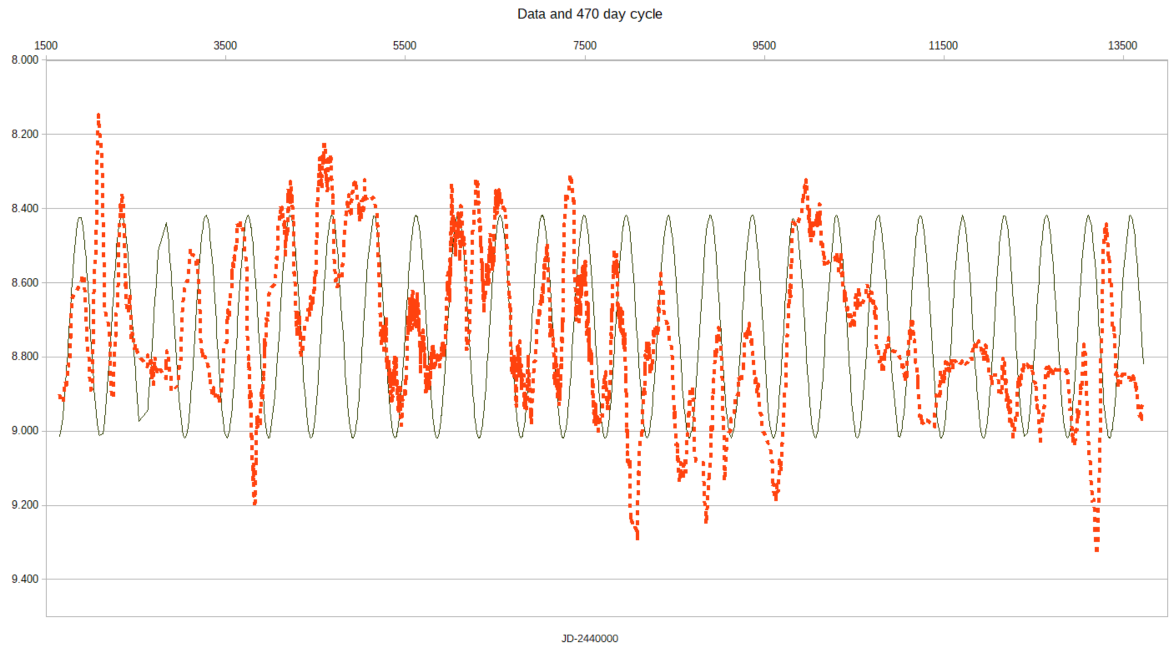


Figure 3

It is obvious that neither cycle fits the data particularly well [and neither do the quoted periods in the first paragraph]. Indeed, in Figure 3 it can be seen that there are times when the 470-day cycle fits well, but it also gets out of synchronisation and disappears entirely. Fourier analysis, and other periodicity seeking tools, indicates a variety of cycles, none clearly defined, dependent on the time period chosen and the method used.

SRc variables are believed to show periodicity at least in part caused by radial oscillations. This, and other factors, is not well understood in detail and a rich set of long-term data is needed to facilitate their study. RS Per is not alone – table 1 below lists similar SRc variables on the BAA pulsating program where more data is needed – note that Perseus is a rich hunting ground. Visual observers should aim for a consistent technique using the same instrument and observe once a week or less frequently. Given the narrow magnitude range of these variables they are ideally suited to (preferably filtered) electronic observation. Observers using CCD or DSLR equipment are strongly encouraged to monitor these stars. Exposure time should be chosen so that the brighter comparison star is not saturated and ideally the fainter comparison has a signal-to-noise ratio of at least 100. Again, consistency in equipment is encouraged. A single observing session should ideally comprise about 30 images in order to smooth out effects of atmospheric brightness variation and other noise. Longer (all night) observation runs would also be useful to monitor for short-term changes in magnitude. Figure 4 illustrates the data obtained from such a run by Pickard using a 35cm SCT, an SXV-H9 CCD with 7 second exposures using a V filter.

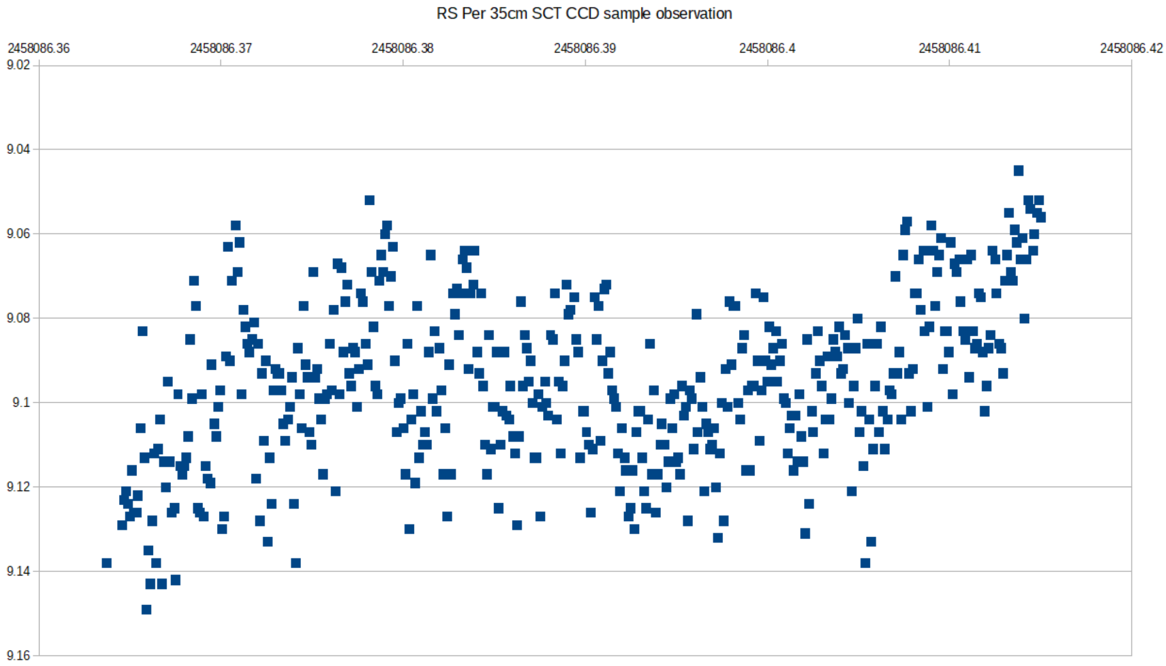


Figure 4

Back to contents

TABLE 1: SRc variable stars on the BAA pulsating program

Star	Spectrum	Magnitude range
W Cep	M2epIa	7.0-8.5
mu Cep	M2eIa	3.7-4.9
BC Cyg	M3.5Ia	9.6-10.5
BU Gem	M1-M2Ia-Iab	5.7-7.4
TV Gem	M1.3Iab	6.3-7.5
Y Lyn	M6sIb	6.8-8.2
XY Lyr	M4.5-M5: II B	5.6-6.6
S Per	M4.5-&Iae C	7.9-12.8
RS Per	M4	7.8-9.0
SU Per	M3.5Iab	7.3-8.7
AD Per	M3Iab	7.5-9.0
BU Per	M3.5Ib	9.0-10.0
W Tri	M5II	7.6-8.8

Acknowledgements:

The author wishes to thank Roger Pickard and John Howarth for their assistance in producing this article.

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1. http://www.britastro.org/vss/ see the "Pulsating" program
2. https://www.aavso.org/vsx/index.php?view=detail.top&oid=25535
3. Kiss et al, MNRAS 372, 4 1721 (2006)

BAAVSS Chart

Spectra of Mira at maximum and minimum

David Boyd

At the time of writing (15 February 2018) Mira is enjoying a protracted period at maximum brightness during its current pulsation cycle. On 13 February I measured it at V=3.16 using a SXV-H9 CCD camera fitted with a Johnson V filter and a 135mm lens. At the same time, I was recording its spectrum with a C11 and LISA spectrograph. I flux calibrated this spectrum using the V magnitude. Figure 1 shows this absolute flux spectrum which is a close match to spectral type M5III. It shows multiple saw-tooth shaped TiO absorption bands and Balmer H-delta and H-gamma emission lines. Emission lines of H-alpha, H-beta and H-epsilon are noticeably absent. These emission lines are formed around maximum brightness as a result of shock waves generated in the outer envelope of the star. According to the literature, the relative strength of these emission lines is a useful diagnostic for studying the radiative hydrodynamic behaviour of the star's shocked atmosphere. Just visible in blue along the bottom of this plot is a spectrum I recorded on 27 October 2017 when Mira was at

V=9.14, not long after it had passed through the minimum of the previous pulsation cycle around the beginning of October. This plot shows the factor of 250 difference in flux between the two states resulting in their 6 magnitude difference. The fainter spectrum is a closer match to spectral type M9III indicating the relatively cooler temperature of the star at minimum. In Figure 2 these spectra are plotted on a log scale which shows they are broadly similar in profile, with the exception of the Balmer emission lines. On 27 October I measured Mira's B and V magnitudes which gave a B-V colour index of 1.96. From photometric observations on the AAVSO website during the current maximum, its B-V colour index is now 1.19. The reason can be seen in Figure 2 where the flux of the earlier spectrum is noticeably lower in the B-band centred at 4300Å relative to the V-band centred at 5300Å.

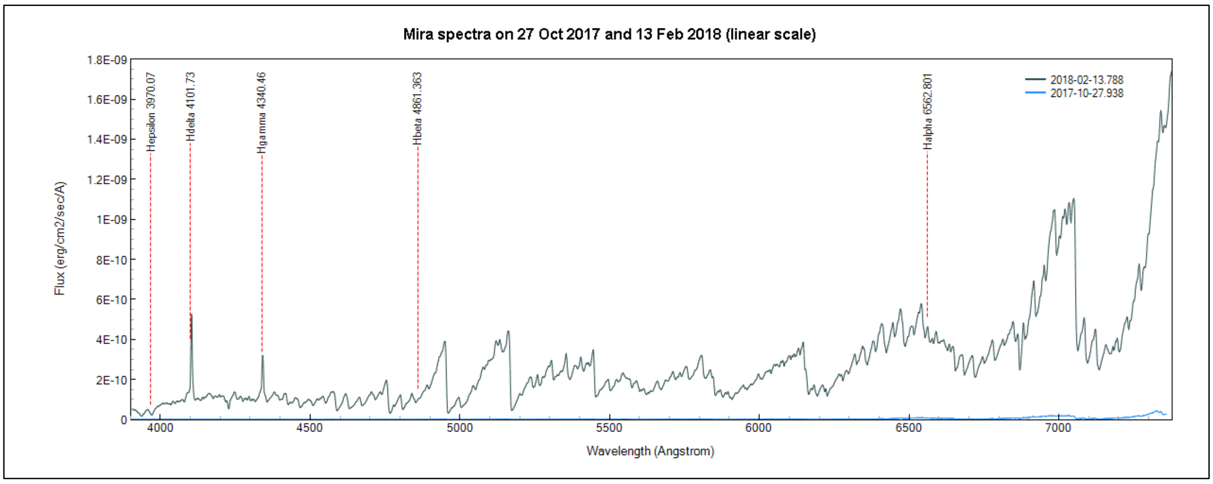

Figure 1: Mira spectra on 27 Oct 2017 and 13 Feb 2018 (linear scale).

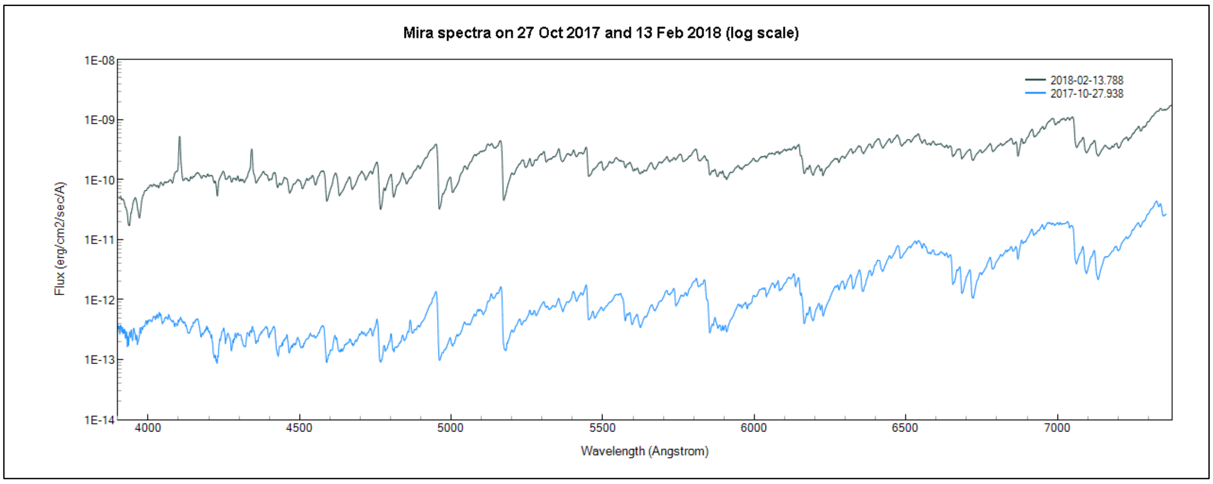

Figure 2: Mira spectra on 27 Oct 2017 and 13 Feb 2018 (log scale).

BAAVSS Chart / VSX

Back to contents

Where are and where were all the bright Novae?

Mark Kidger

Although supernovae in the Milky Way are a rare and infrequent phenomenon and it has been more than four hundred years since the last was observed, observers have been more fortunate with novae. CP Pup, in 1942, reached +0.5, GK Per, in 1901, reached magnitude +0.2, while V603 Aql, in 1918, got as bright as magnitude -1.1. Observing a bright nova must be on the bucket-list of many astronomers.

Novae are also of historical interest. T CrB's outbursts to magnitude 2 in 1866 and magnitude 3 in 1946 have many astronomers anticipating that a new, bright outburst may come soon. Similarly, one of the key pieces of evidence in the case of the Star of Bethlehem is the record of the object seen in March 5BC, classed by Clark and Stephenson (1976, 1977) as a probable nova on the basis of its long duration and fixed position. However, at the same time, people make great store of the evidence that the Chinese records are seriously incomplete between 20 BC and 1 BC because there is a shortage of both comets and novae in the Chinese chronicles for this period. Similarly, people look at the long interval since the last bright nova was observed and start to wonder where the bright novae have gone.

If we take the 20th Century as a guide, bright novae have been extremely common, so we would expect them to have been just as common two thousand years ago. The list of novae that reached at least magnitude +2 in the 20th Century is impressive (see: https://projectpluto.com/galnovae/galnovae.htm, or the Central Bureau for Astronomical Telegrams list at: http://www.cbat.eps.harvard.edu/nova_list.html), especially when we consider that the 19th Century closed with a bright nova in 1898:

Name	Year	Magnitude
GK Per	1901	0.0
V603 Aql	1918	-1.1
V476 Cyg	1920	2.0
RR Pic	1925	1.1
DQ Her	1934	1.2
CP Lac	1936	1.9
CP Pup	1942	0.4
V1500 Cyg	1975	1.8

That makes an average of one nova of magnitude +2 every ten years over eight decades, with an extraordinary six of them appearing in twenty-four years between 1918 and 1942.

There are just fifty stars in the sky that are magnitude +2.00 or brighter – exactly fifty, in fact – thus, we may assume, quite reasonably, that any new object of magnitude 2 or brighter should be unmistakeable to anyone with a good knowledge of the sky. Proof of this is that when Nova Cygni blazed out on August 29th, 1975, it was discovered by Osada, in Japan (Osada, Honda et al., 1975) and, at nightfall in Europe, anecdotal evidence is that literally hundreds of people discovered it independently. To my enormous chagrin, I missed observing the nova myself: it appeared on a Friday evening; I only heard about it on Sunday night when watching the August "Sky at Night" and, by the time that I had a chance to look for the nova myself, on the Monday night, being a very fast nova (Grey, 2018, lists T3=3.6 days), it was already as faint as magnitude 5 and fading fast.

Since 1975 though, if we take magnitude +2 as the peak magnitude that defines what is a bright nova, there have been no bright novae in what is now more than forty-two years. Of the 239 novae discovered since Nova Cygni 1975 that are listed by Grey (2018), the brightest have been: Nova Centauri 2013, at magnitude 3.3 (in the far south of the sky); Nova Scorpii 2007/1, at magnitude 3.9; Nova Cygni 1992, at magnitude 4.2 and Nova Sagittarii 2015/2, at magnitude 4.6. All were naked-eye visible, but none were bright enough to be unmissable in the way that the objects listed in the table above were.

There is a feeling among observers that the sky owes us a bright nova. Warner (2006) formulated the question: "where have all the bright novae gone?" However, we can also look further back into the records of novae since 1600 and what is generally accepted to be the dawn of modern astronomy and attempt to get a better idea of the statistics. Maybe the 20th Century has been a statistical anomaly and bright novae are not as common as they appear. Of course, this modern period started in spectacular fashion with Kepler's Supernova in 1604. Between 1600 and 1900 there are just thirty-nine reports of novae or nova-like objects in Grey's list[1], all but five of them posterior to 1840. That though is to be expected, as techniques became more sophisticated, fainter novae were being detected more systematically.

However, the distribution still looks non-random. Only one nova was reported in the entire 18th Century and that was the magnitude 6, Nova Sagittae 1783. In contrast, there were two novae of magnitude 3 or brighter reported in the 17th Century (Nova Vulpeculae 1670 and Nova Puppis 1673, although the former is no longer regarded as a classical nova (Evans et al, 2002)) and three between 1848 and 1900 (Nova Ophiuchii 1848, Nova Cygni 1876 and Nova Sagittarii 1898).

Whatever way you look at the numbers though, there were far fewer bright novae reported between 1600 and 1850 than between 1850 and 2000. And the period between 1898 and 1975 contains all but one of the bright novae reported since 1600.

There are two obvious possible explanations for this:

- The peak in the frequency of appearance of bright novae between 1898 and 1975 is a genuine statistical anomaly and that bright novae are, on average over a long period, less common.

- The peak in the frequency of appearance of bright novae between 1898 and 1975 is due to statistical bias in discoveries.

In the former case, it is a real effect that appears for an unknown reason. Maybe it is just that we were extraordinarily fortunate to see so many bright novae in such a short period of time. Sometimes you will just get lucky tossing a coin and toss ten heads in a row but, the longer that you continue to toss the coin, the more the number of heads and tails will even out. In other words, any statistical series will come twice as close to the long-term mean over four centuries as it does over one, if we are treating pure Poisson statistics (a purely random phenomenon).

[1] This includes the outburst of the recurrent nova T Coronae from 1866 and Eta Carinae in 1843, which are frequently excluded from lists as neither is a classic nova. I propose not to treat either as a genuine nova.

Back to contents

This effect is well known to meteor observers (and to users of London buses). Poisson statistics have the effect that meteors appear to appear in bunches, separated by long intervals: even around Perseid maximum you can have periods of five, ten or even fifteen minutes when not a single meteor appears and then three or four bright ones appear almost simultaneously – the average ends up being close to one-a-minute, but there are statistically more intervals shorter than an minute than longer ones and so the impression is that the meteors appear grouped-together in a totally non-random fashion.

In the latter case though, we would have to assume that the novae were appearing but were not being detected for some reason. Dick (1859) points out that Tycho only noticed the 1572 supernova when he came upon a crowd of people staring at it as he returned home late in the evening. Maybe, as Warner (2006) suggests "ordinary novae with apparent magnitudes between -1 and +2 were largely ignored from the 16th until the 20th century" and, less surprisingly "in Western Europe almost all novae before 1850 were found accidentally — no deliberate watch for novae appears to have been kept", despite the catalogue of great observers active in the 17th and 18th centuries.

There is one obvious reason why nova discoveries were much less frequent prior to 1850 and that was the lack of systematic observing of the southern sky. Of the bright novae of the 20th Century listed above, one could not have been discovered from the northern hemisphere and another would have been difficult to observe and even more difficult to discover except from the extreme south of Europe. We can suggest that an entire third of the sky was little-observed prior to the mid-19th Century and that novae in that third of the sky would not have been discovered: that reduces the anomaly a little. Is it reasonable to argue, as Warner (2006) has, that the rest of the anomaly is down to observers just not noticing when a bright nova appeared?

The 17th, 18th and early 19th centuries featured a large number of renowned visual observers. Apart from the astronomers who mapped the sky and added new constellations and those who produced increasingly voluminous star catalogues, many assiduous observers such as Messier, Méchaine, Pons and William Herschel were active. The large number of increasingly faint comet discoveries is evidence that there was intense scrutiny of the sky and that anomalies were being picked up, although it is true that nebulous objects stood out to these observers more than stars, as evidenced in turn by the fact that it was not until a systematic search campaign was initiated, that even the brightest asteroids were discovered, albeit the first asteroid discovery was made accidentally and not by the so-called Celestial Police. However, it was also a time when everyone knew the constellations as well as their own neighbourhood and you would think that a nova of magnitude +2 would be noticed immediately by hundreds of people and commented, as were the supernovae of Tycho and Kepler.

As such, even if a significant fraction of bright northern hemisphere novae were simply missed, one has to suspect that the frequency of bright novae must have been lower than it was at the peak in the 20th Century.

We can also get a hint at the frequency of bright novae in the past from Chinese records. Table 3.1 of Clark and Stephenson (1977) lists their seventy-five candidate novae and supernovae of the pre-telescopic era from Oriental records. They class the reliability of identification of objects as a nova or supernova on a 5-point scale from 1 to 5, with objects of class 1 and 2 likely or certain novae of supernovae and classes 4 and 5 extremely tentative candidates. Astonishingly, for a record that covers two thousand years, there are just twenty objects that were of long duration and high reliability, nine of which are now known to have been supernovae. The 5BC Star of Bethlehem candidate is the only high-reliability nova/supernova candidate object in BC dates. Granted that in choosing long duration of visibility as a criterion Clark and Stephenson were biasing their statistics against fast novae but, even if we eliminate the period between 500BC and 1BC for which we know many records were lost, one strong nova candidate every century and a half seems an astonishingly small number. An interesting anomaly is 1592, in which year there are no less than three likely nova candidates, all observed from Korea: it has though been suggested by Clark and Stephenson (1977) that these three records could, possibly, be of a particularly bright maximum of Mira Ceti[2].

As a result of the very small number of Chinese nova candidates, we might suggest that the lack of records is simply a statement that the Chinese were only interested in K'o-hsing – Guest Stars – if they were particularly brilliant: it seems likely that anything that was not negative magnitude was not of any great interest, while the very brightest and longest-enduring objects were described in great detail.

So, we come back to the original question: where are the bright novae now and where were they in the past?

My guess is that:

- The high frequency of bright novae between 1898 and 1975 was a statistical anomaly. Rather than 10 per century, the true rate is more likely to be 3-4, consistent with the observed rate through the 19th Century and, certainly, lower than 5. Evidence for this is the fact that there has been just one bright nova in the 76 years since 1942, consistent too with the rate of bright novae in the 19th Century.
- Part of the deficit of novae in the 17th and 18th centuries can be explained as due to a lack of coverage of the southern hemisphere. If random chance deemed that several consecutive bright novae happened to fall in the southern hemisphere (i.e. similar to obtaining 3 or 4 consecutive heads when tossing a coin) a century could pass without a single, bright nova being observable from the latitude of the British Isles or Germany.
- The lack of recorded bright, Chinese novae can be attributed to a combination of bright novae being less common than recent statistics have led us to believe, to the Chinese only recording K'o-hsing that were particularly bright and to the selection effect of only regarding objects of long-duration as candidate novae, thus eliminating most fast novae from the statistics.

If so, the fact that we have not seen a bright nova since Nova Cygni 1975 is not a statistical anomaly: it is a reflection that the statistics are normalising and that, like London buses, we must be patient and, suddenly, three will come along at once. In this case, long-term, observing a bright nova may actually be a once or twice in a lifetime event, rather than a regular occurrence and those people who observed so many bright novae in the first half of the 20th Century were extraordinarily fortunate. It also makes the 5BC event, if it was a nova, a far more significant object than we have believed it to be thus far.

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[2] The coordinates show a significant discrepancy with the position of Mira, but such disagreements are not unusual given that the Chinese gave the name of the closest asterism as a position and, in less rich areas of sky, the nearest asterism could easily be 5-10 degrees away from the position of the object.

UCAC4 681-054961: A new eclipsing binary in the field of ASASSN-16fy

Ian Miller

This new variable star (= SDSS J140205.05+461100.3 = GSC 03465-00810) was discovered during a search for comparison stars to measure ASASSN-16fy in June 2016. An accurate position, 14 02 05.51 +46 11 00.33 (J2000), is given in the Sloan Digital Sky Survey Photometric Catalogue [1]. No variables were found within 2 arcmin of this position in the SIMBAD and VSX databases or General Catalogue of Variable Stars [2]. The B-V colour of UCAC4 681-054961 is listed as 0.98 in the fourth U.S. Naval Observatory CCD Astrograph Catalogue [3]. The field of ASASSN-16fy is displayed in Figure 1.

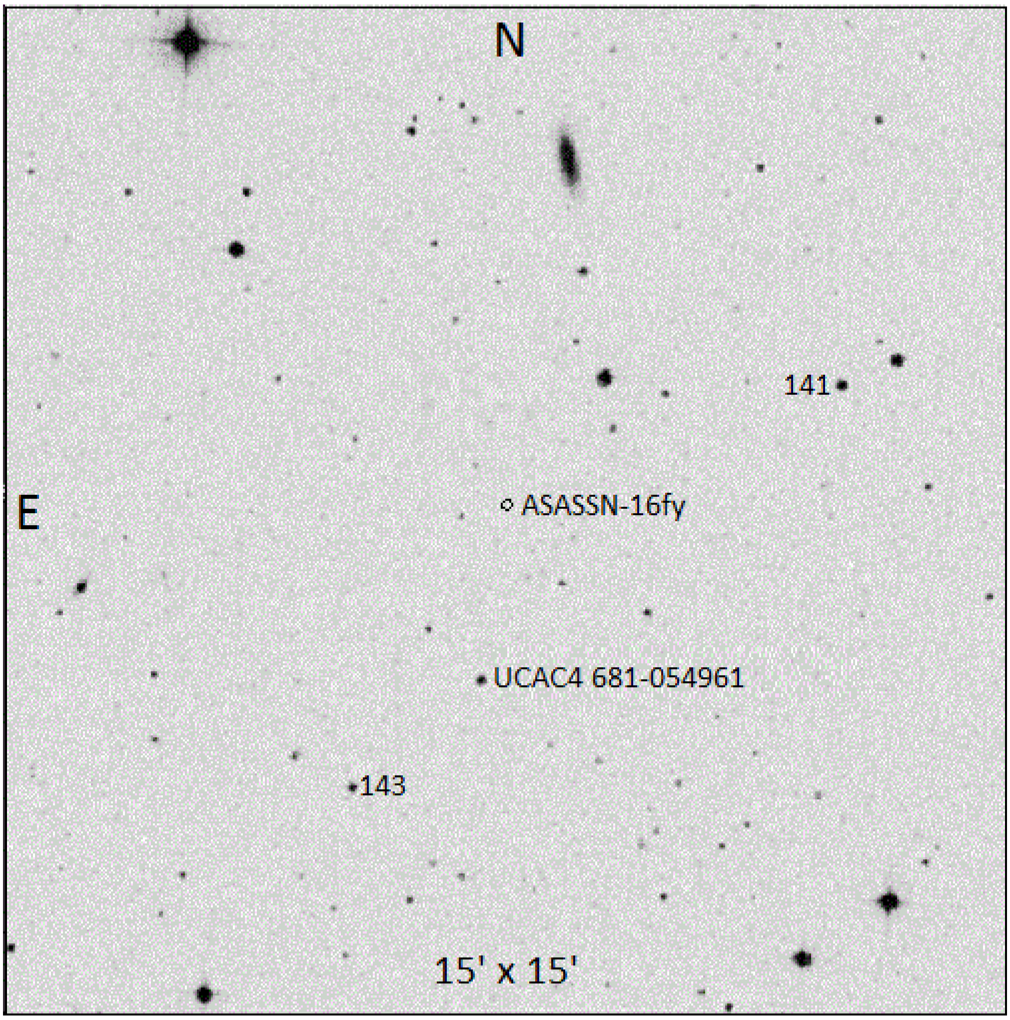

Figure. 1. The field of ASASSN-16fy showing the positions of UCAC4 681-054961 and the comparison stars used for these observations

Differential photometry was carried out with a 0.35m SCT and SXVR-H16 CCD camera at Furzehill Observatory over ten nights. A log of the observations is presented in Table 1.

Date (UT)	Start (JD)	End (JD)	Duration (h)	Images	*Filter
17-Jun-2016	2457557.42127	2457557.55289	3.16	165	CV
25-Jun-2016	2457595.41877	2457595.48515	1.59	60	V
6-Nov-2017	2458063.69984	2458063.73697	0.89	33	CV
8-Nov-2017	2458065.69356	2458065.75691	1.52	59	CV
13-Nov-2017	2458070.69170	2458070.75725	1.57	60	CV
17-Nov-2017	2458074.68826	2458074.71339	0.60	20	CV
25-Nov-2017	2458082.66639	2458082.78106	2.75	106	CV
26-Nov-2017	2458083.70794	2458083.78053	1.74	62	CV
12-Dec-2017	2458099.65049	2458099.78882	3.32	137	CV
19-Dec-2017	2458106.62160	2458106.63707	0.37	15	CV

**CV = Clear filtered with V band comparison star, V = Johnson V*

Table 1. A log of the observations

The resulting images were dark subtracted and flat fielded prior to being measured relative to stars 141 and 143 in the AAVSO's V magnitude sequence X16261ZJ for ASASSN-16fy. The average uncertainty of the measurements is 0.018 in CV and 0.022 in V. These observations confirmed that UCAC4 681-054961 is continuously variable with range 14.5 – 14.85V.

The times of the clear filtered observations were then converted to Heliocentric Julian Dates (HJDs) prior to carrying out a period search using the Lomb-Scargle, ANOVA and PDM methods in Peranso [4]. The outcome, plotted over two cycles in Figure 2, revealed that UCAC4 681-054961 is an eclipsing binary with a period near 0.2766 days (6.64 hours).

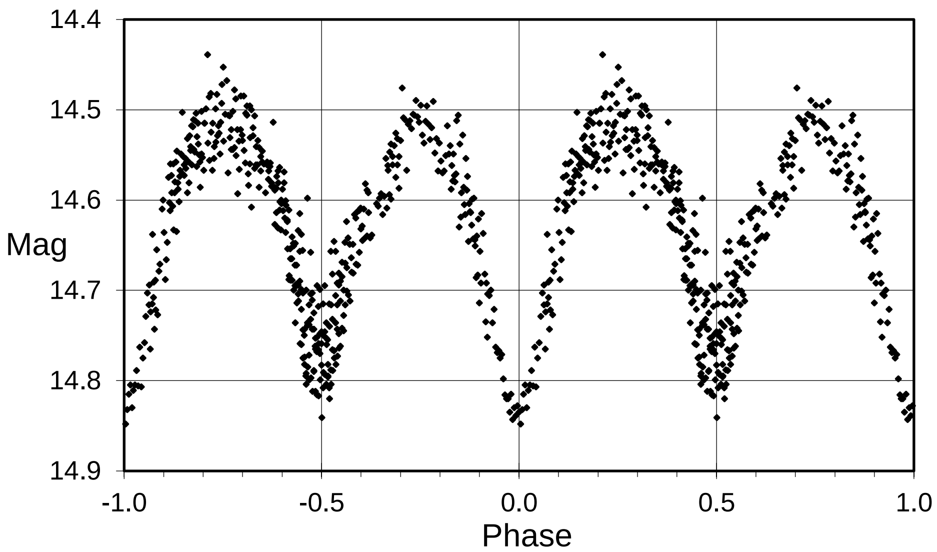

Figure. 2. The clear filtered observations folded on 0.2766 days

The deeper primary minima are centred on phases -1, 0 and +1 in Figure 2. The HJDs of six eclipse minima were ascertained using the linear Interpolation Method in Peranso. Dividing the time lapse between the deeper minima on 17th June 2016 and 25th November 2017 by the Peranso 0.2766-day period yielded a figure of 1899.11 cycles. Rounding this cycle number down returned a more precise value of 0.2766161 days for the average orbital period between these two minima.

Consequently, the ephemeris of the primary eclipse minimum of UCAC4 681-054961 is estimated to be

HJD 2457557.46311 (June 17, 2016) + 0.2766161*E

in which E is the primary cycle number. Utilising this ephemeris, the fraction needed for the average 'observed minus calculated' (O-C) phase of the secondary minima to be zero is 0.4985. The primary and secondary eclipse measurements are summarised in Table 2.

Cycle Number	Date(UT)	HJD (Minimum)	+/- (d)	CV Magnitude (Minimum)	Eclipse Type	Phase O-C
0	17-Jun-2016	2457557.46311	0.00015	14.85	Primary	0
1837.4985	8-Nov-2017	2458065.74052	0.00014	14.77	Secondary	-0.015
1855.4985	13-Nov-2017	2458070.72120	0.00023	14.77	Secondary	-0.009
1899	25-Nov-2017	2458082.75704	0.00015	14.84	Primary	0
1902.4985	26-Nov-2017	2458083.72602	0.00031	14.81	Secondary	0.004
1960.4985	12-Dec-2017	2458099.77409	0.00021	14.81	Secondary	0.020

Table 2. The observed eclipse minima

The shape and period of its light curve, and the near 0.5 phase of its secondary minima, suggest that UCAC4 681-054961 is an EW type close-contact eclipsing binary with a circular orbit. It is also likely that the large range detected in its secondary eclipse depths is caused by an intrinsic variability, such as star spots.

Acknowledgements:

This research used the SIMBAD database, operated by the CDS at Strasbourg, France, and the VSX database and Variable Star Plotter operated by the AAVSO.

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Comments on the eclipsing binaries RT And, TV Cas, BH Dra, BV Dra and BG Gem

Christopher Lloyd

In recent issues for the Circulars Des Loughney has drawn attention to several interesting eclipsing binaries, some of which may provide useful targets for observers with DSLR cameras. Four of the stars are well within the DSLR range both in terms of magnitude and period, but one is clearly not.

Although BG Gem is a curious object, at V ~ 13.4 it is not suited to the DSLR observer. It is still listed in the GCVS and Simbad as an RV Tauri star (a pulsating supergiant) but has been recognised as an eclipsing binary since the first comprehensive study of the system by Benson et al., (2000). The light curve is thought to be dominated by the ellipsoidal variation of a cool supergiant star but the analysis is complicated by the presence of a disc around the hotter component which may be a B-type star or a black hole (see Kenyon et al., (2002) for their most recent paper).

The light curve resembles that of a beta Lyrae star with unequal minima except that the period instead of being a few days is 91.6 days and it takes 12 days to descend and recover the 0.2 magnitudes around primary minimum. Because this star is not widely recognised as an eclipsing system very few times of minimum have been published. The O-C diagram is shown in Figure 1 and there is no evidence of any period change. The ephemeris of primary minimum is

$$HJD_{MinI} = 2449409.22(11) + 91.6058(18) \times E$$

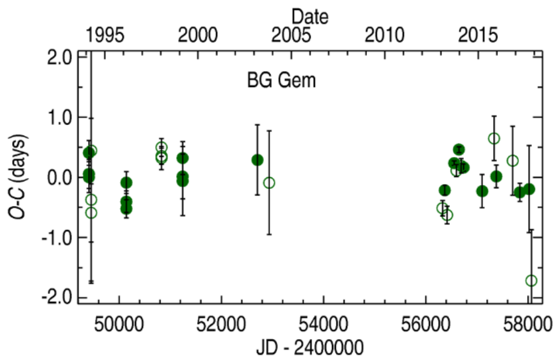

Figure 1. The O-C diagram of BG Gem showing the times of minima for primary (filled symbols) and secondary (open symbols) eclipses. There is no indication of any period change.

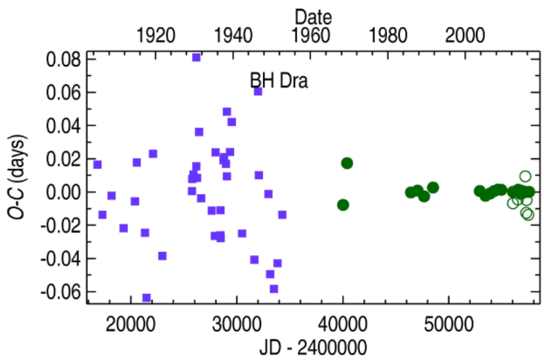

Figure 2. The O-C diagram for BH Dra showing the early photographic (squares) and the more modern photoelectric and CCD results. The secondary eclipse provides much less reliable times of minimum and again there is no indication of period change.

By contrast BH Dra is a detached Algol system with a period of 1.8 days and a range of V ~ 8.4 – 9.3 so is a potentially useful target for DSLR observers (see light curve). However, the O-C diagram in Figure 2 shows no variation in the period over the past century. The ephemeris of primary minimum is

$$HJD_{MinI} = 2440019.7959(35) + 1.8172383(5) \times E$$

Given the lack of activity this system needs only occasional monitoring, perhaps every season or two and the secondary eclipse should be avoided as it provides much less reliable times of minimum.

TV Cas is also apparently a detached Algol binary with a period of 1.8 days but its behaviour is very different. It varies between V ~ 7.2 and 8.2 and has only a weak secondary minimum (see light curve). It has been observed for over a century and the period is clearly variable, but it is not a simple secular change (see Figure 3). Hoffman et al., (2006) make the case for a third body in the system along with a secular change in the period to account for variation in the O-C diagram. Their period of about 24000 days fits the data at some level but there may be additional low-level activity on a time scale of ~ 7000 days if the recent variations are to be believed (see Figure 4). The ephemeris of primary minimum for the recent data is

$$HJD_{MinI} = 2445990.9080(12) + 1.81258996(27) \times E$$

which should be good to better than 0.005 days for some years. The unexpected behaviour in the O-C diagram together with the favourable magnitude and period make this system a very good candidate for DSLR observers but the times of minimum need to be well determined. The scatter in the recent values is ~0.002 days so the minima need to be good to at least this level. Although this is an active system only one or two good times of minimum are required every season.

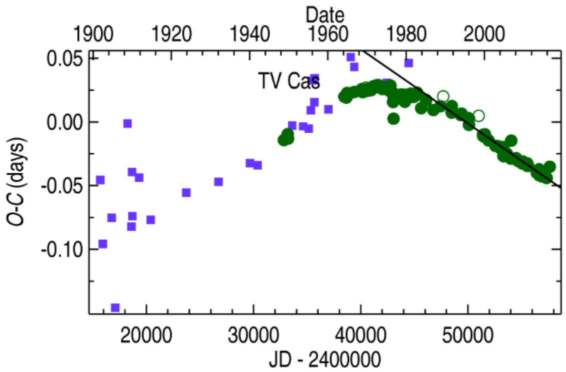

Figure 3. The long-term O-C diagram of TV Cas (symbols as before). The variations can be fitted by a secular change and a long period of a third component. The line represents the recent ephemeris used in Figure 4.

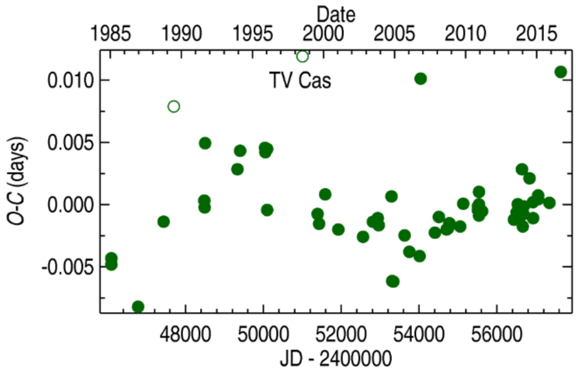

Figure 4. The O-C diagram of the recent data for TV Cas apparently showing an apparent cycling of the residuals on a time scale of ~7000 days.

The last two stars are short-period systems, and both show period changes on multiple time scales. RT And is an RS CVn system with a period of 0.63 days and a range of V ~ 9.0 – 9.8. The light curve closely resembles that of an Algol variable but it also shows chromospheric activity. The full O-C diagram covering nearly a century given in Figure 5 shows a large secular change with additional periodic variations probably related to magnetic cycles in the star. Variations on a time scale of ~ 12 years can be seen in the O-C diagram of recent data in Figure 6. However, there seems to be some inconsistency in the time scale of the chromospheric activity and the variation in the O-C diagram. See Zhang & Gu (2007) and Manzoori (2009) for details. The ephemeris of primary minimum for the recent data is

$$HJD_{MinI} = 2451463.24693(13) + 0.628928811(28) \times E$$

Back to contents

which should be good to better than 0.002 days for some years. RT And is also a good candidate for monitoring every season although the weak and less reliable secondary eclipse should be avoided.

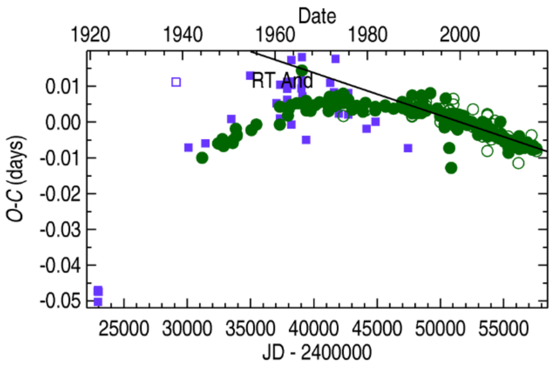

Figure 5. The long-term O-C diagram of RT And (symbols as before).

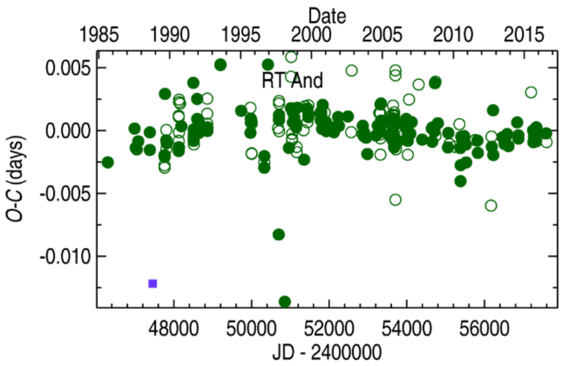

Figure 6. The recent activity of RT And showing an approximate 12 year variation.

The last star in this group also has the shortest period. BV Dra is a weak contact W UMa system with a period of 0.35 days and a range of V ~ 7.7 - 8.3, with two similar minima. The O-C diagram for BV Dra extends back to only 1970 but even so the system clearly shows period changes, although exactly what form these take is not clear. An analysis by Yang et al., (2009) considered a cyclical change due to a third body but it seems likely that changes are due to intermittent mass transfer from occasional contact between the two components. The recent ephemeris of primary minimum is

$$HJD_{MinI} = 2451636.3427(13) + 0.35006764(12) \times E$$

Given the uncertain nature of the period changes in this system, the magnitude and very short period this is an ideal candidate for DSLR monitoring, but the timings need to be good to <0.002 days. In this system both eclipses are almost the same depth and the timings of the secondary seem to be as reliable as those of the primary, offering additional opportunities to make timings.

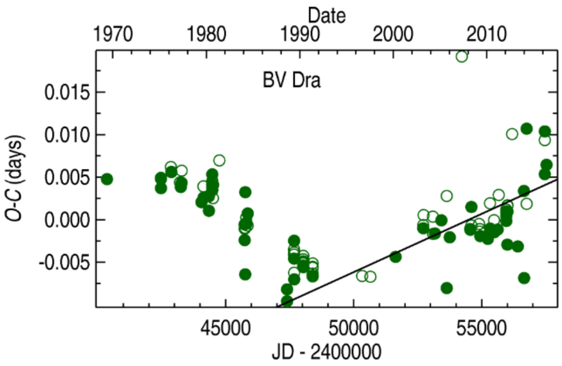

Figure 7. The O-C diagram for BV Dra probably showing two constant periods with an abrupt change, but the long-term behaviour is not clear. The line is the recent ephemeris.

Back to contents

Artists Impression of the evolution of a high-mass binary star

The European Southern Observatory have produced a video showing how hot, brilliant and high-mass stars evolve in an apparent EB simulation. The Video can be seen here.

Runaway Star - Zeta Ophiuchi

Below is the Wikipedia caption for Zeta Ophiuchi. Zeta Oph is supposed to have been in a binary system. The primary star exploded as a type II supernova and propelled Zeta Oph away at a speed of 30km per second. The image was taken with NASA's Wide Field Infrared Survey Explorer or WISE.

"Runaway star Zeta Ophiuchi plowing through space dust. The bright yellow curved feature directly above the star is a bow shock. In this image, the runaway star is flying from the lower right towards the upper left. As it does so, it's very powerful stellar wind is pushing the gas and dust out of its way (the stellar wind extends far beyond the visible portion of the star, creating an invisible 'bubble' all around it). And directly in front of the star's path the wind is compressing the gas together so much that it is glowing extremely brightly in the infrared, creating a bow shock. Image via NASA."

NASA/JPL/-CalTechUCLA.

Astronomers find eclipsing binary system of M dwarf stars

Astronomers studying archival data collected by the Sloan Digital Sky Survey and the Catalina Sky Survey discovered a never before seen EB system composed of two low-mass M-dwarf stars. Designated SDSS1156-0207, the newly-found system is composed of two very faint stars (V=15.89) that orbit each other every 0.3 days.

The larger star measures 0.46 solar radii and has 0.54 solar masses. Its smaller companion has a radius about 30 percent that of the Sun and just 0.19 solar masses. Separated by just 0.0077 AU (716,000 miles) both stars are tidally locked to each other.

M-dwarfs, especially in eclipsing binaries, could be crucial for improving our understanding about fundamental stellar parameters of low-mass stars and, in time, their evolution.

Reference

SDSSJ1156-0207: A 0.54 M_sun + 0.19 M_sun Double-lined M Dwarf Eclipsing Binary System
Chien-Hsiu Lee (Subaru Telescope, NAOJ)

Back to contents

68u Herculis

This is a system which is on our observing list. It has a confusing nomenclature. It is not U Herculis which is a Mira type system. It does not seem to be known as u Herculis. The most common name is 68 Herculis. However, on the Krakow site it is known as U Herculis which is not correct. Also, on the Krakow and the GCVS sites it is listed as an EA/SD system. The literature, which includes light curves, describes a light curve which indicates reflection effects and distorted stars. 68 Her seems to be actually in between an EA and an EB (Beta Lyrae) system. It is probably closer to being an EB system (see <https://www.universeguide.com/star/68herculis>) and is therefore misclassified by Krakow.

As an EB system it is always varying and therefore worth measuring at any time. As it has a period that is nearly an even two days it will not be observable from the UK for some time but then it will be observable for a long time. At the first opportunity I intend to look at this system and try and work out a contemporary light curve. Observing should be straightforward at it is bright (around 4.7), has a secondary eclipse of 0.2 depth and a primary eclipse of 0.8 depth. The latest period is 2.0510252 days. Stars that are so close together are always worth monitoring. The BAAVSS does not have an update chart for the system and there is not one on our website. A chart dating back to 1971 can be obtained from myself. I will be looking at the latest magnitudes for the comparisons and, in effect, updating the chart.

Formation of binaries/eclipsing binaries - according to Wikipedia

“While it is not impossible that some binaries might be created through gravitational capture between two single stars, given the very low likelihood of such an event (three objects are actually required, as conservation of energy rules out a single gravitating body capturing another) and the high number of binaries, this cannot be the primary formation process.

Also, the observation of binaries consisting of pre main-sequence stars, supports the theory that binaries are already formed during star formation. Fragmentation of the molecular cloud during the formation of protostars is an acceptable explanation for the formation of a binary or multiple star system.

The outcome of the three-body problem, where the three stars are of comparable mass, is that eventually one of the three stars will be ejected from the system and, assuming no significant further perturbations, the remaining two will form a stable binary system.”

For EB predictions and where to find them, see here

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Deadline for the next VSSC is May 15th, 2018

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Back to contents

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Back to contents