British Astronomical Association

VARIABLE STAR SECTION CIRCULAR

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Contents

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Office: Burlington House, Piccadilly, London, W1J 0DU

Variable Star Section

BAA VSS SECTION MEETING

Saturday, 19th March 2016

Our hosts will be:

NORTHAMPTON NATURAL HISTORY SOCIETY

Humfrey Rooms,
Castilian Terrace,
Northampton NN1 1LD

PROGRAMME

10:30 Doors Open. Refreshments available

11.00 Welcome and Introduction - Roger Pickard, Director

11.10 Dr David Boyd - What does 15 years of data tell us about DW UMa?

11.30 Des Loughney - RX Cas

12.00 Dr John Southworth, Keele University -What is the point of observing eclipsing binaries?

1.00 Lunch

2.15 Simon Hodgkin, Cambridge Astronomical Survey Unit - Science Alerts from Gaia.

3.15 Andy Wilson - Update to the VSS Database

3.25 Chris Jones - The ICCE programme

3.45 Tea

4.20 Gary Poyner - A telescopic Variable Star hop around the arrow.

4.40 John Toone - America's first Variable Star.

5.00 Shaun Albrighton - The Binocular Programme

5.30 End

Costs: The cost will be £7 for members and £10.00 for non-members to include refreshments throughout the day. There are many facilities in the area offering everything from sandwiches to a full menu.

FROM THE DIRECTOR

ROGER PICKARD

Ian Middlemist

It was very sad to hear that Ian Middlemist died of cancer on Christmas Day.

Ian submitted over 36,000 observations during a 30-plus year period. A fantastic achievement and a great contribution to variable star astronomy. This includes 572 observations of AB Aurigae from 1973 to 2002. Sadly, there are some large gaps in the data that I hope we will still be able to fill. However, in one of his last communications to me, back in 2012, he advised that he had had to get rid of most of his old records due to space limitations. In addition, he said that his binoculars were mostly used for bird watching nowadays.

Furthermore, he had also advised Melvyn Taylor back in 2003 that he had had to give up observing altogether because there were just too many street lights around him.

A summary of his observations can be viewed at the following page:
http://britastro.org/vssdb/observer_summary.php?obs_id=MM&sm_view=stars

I am also grateful to Colin Henshaw for writing the short piece about Ian that appears later in this Circular.

V404 Cyg

You may recall that, back in June 2015, V404 Cygni went into outburst - after some 26 years. The first signs of activity were reported via the various X-ray detectors in space.

The news quickly spread to the amateur community and their observations, as well as those of the professionals, revealed that observations in visible light (and especially those in the “I” band) could reveal the flickering light emerging from the gases surrounding the black hole. The team’s results have just been published in Nature and their paper can be downloaded here:

http://www.nature.com/nature/journal/v529/n7584/full/nature16452.html

The lead author of the paper, Mariko Kimura, a master’s student at Kyoto University said “We now know that we can make observations based on visible light, and that black holes can be observed without the use of X-ray or gamma-ray telescopes.

The team obtained unprecedented amounts of data from V404 Cygni, detecting repetitive patterns having timescales of several minutes to a few hours. The optical fluctuation patterns were correlated with those of X-rays.

Three members of the BAA VSS are listed as co-authors on the paper in recognition of the high quality optical data they supplied to the research team - Ian Miller, Nick James and Roger Pickard.

Seeing changes greater than one magnitude in less than an hour, and some high frequency changes occurring in the minutes range, was a wonder to see.

VSS Meeting

A couple of changes to the programme of this meeting have been forced on us by the fact that both professional speakers have had to pull out due to other (professional) commitments.

However, I am delighted to advise that both have been replaced and so the revised programme is on the inside front cover.

roger.pickard@sky.com

A MEMORY OF IAN MIDDLEMIST

Colin Henshaw

The veteran variable star observer, Ian Middlemist, died of cancer on Christmas Day.

Ian and I launched the North Western Association of Variable Star Observers in 1976, along with Jeremy Bullivant, in order to promote variable star observation in the region. The Association grew rapidly, and became an international group with a large following in Eastern Europe. One of its notable achievements was the coverage of the fade of AB Aurigae that was largely missed, yet was detected, unbelievably, from Greater Manchester. Ian phoned me saying that he had seen the star faint at around 8.4m early in the morning. I had seen it earlier in the evening, slightly faint but not faint enough to justify sending out a report. It was clear the following night and I recorded it faint at 8.4m, confirming Ian's observation, but on subsequent nights it had returned to normal. It did not fade again until 1997, when it was recorded faint by fellow NWAVSO member John Toone. This led to speculation as to whether these fades are eclipses, in which case it can be expected to fade in 2019.

The NWAVSO was eventually amalgamated with the Variable Star Section of the BAA in 1980.

NOVA M31 2015-11C (?) DISCOVERY

Guy M Hurst
Coordinator, UK Nova/Supernova Patrol

On 2015 November 22, George Carey of Bromsgrove Astronomical Society was co-discoverer with K. Hornoch (Astronomical Institute, Ondrejov, Czech Republic) of a nova in the Andromeda Galaxy M31. In the absence of Guy Hurst, then in Canada, Nick James and Denis Buczynski, of 'The Astronomer Alert Team', investigated George's report, and the discovery claim, in conjunction with that of K. Hornoch, appeared in The Astronomer's Telegram 8327. George's discovery was on an image taken on 2015 Nov 22.7UT with a 0.20 m telescope (see opposite). The Central Bureau's WWW site allocated the temporary designation PNV J00433852+4128026. David Bishop also gave it a provisional name of Nova M31 2015-11c.

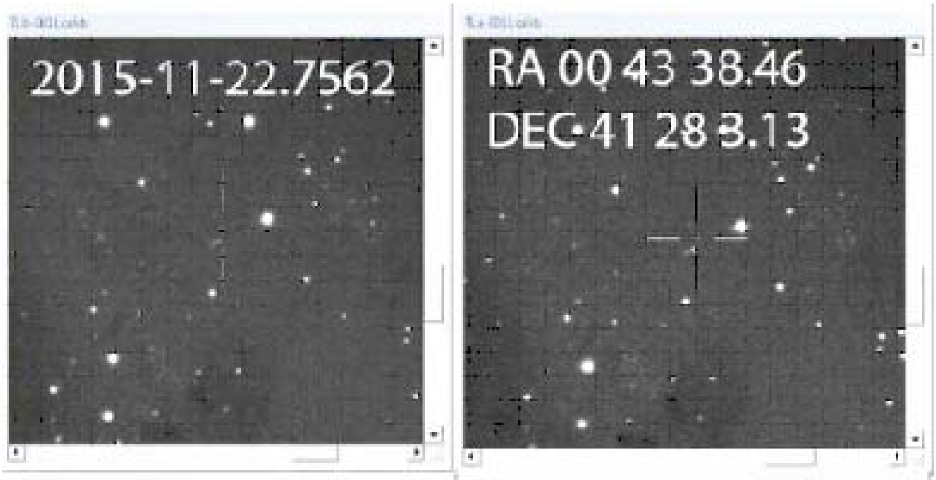
The object, of approximately magnitude 17, is located at: R.A. = 0h 43m 38s.52, Dec = +41º 28' 02".6 (equinox 2000.0), which is 610.1" east and 714.1" north of the centre of M31.

Before the discovery, on a recent visit to Bromsgrove Astronomical Society, the patrol coordinator met with George Carey after giving a talk about astronomical transients. It was agreed that suspects could be reported to us for investigation as George was joining the UK Nova/Supernova Patrol.

The telescope is a homemade carbon fibre tube Newtonian reflector with an 8” mirror. The primary is a top class Carl Zambuto mirror (1/26th wave) with a 1/30th wave secondary by Antares Optics. Details of construction are here:

http://geoastro.co.uk/zambuto1.htm

George Carey: Discoverer



Discovery images for the M31 nova, 2015 November 22.718 (George Carey)

George uses a QSI 683 CCD camera with a Lodestar for guiding. For the nova search he takes 10 minute exposures with the luminance filter. The field of view is 38 x 51 arc minutes, so to cover the bulk of M31 the mount moves to four different positions with the core of M31 positioned in a corner of each frame. The process is repeated so that two images are obtained for each position. A small image shift with each pair of images helps to eliminate hot pixels and cosmic ray artefacts. Operation of the equipment takes place from the warmth of his study via a network link.

After calibration with flat, dark and bias frames the two images, plus a reference image from a previous night, are aligned with RegiStar, and plate solved with Pinpoint. George then uses the asteroid search facility in Pinpoint to ‘blink’ the images. A candidate nova will then appear twice in the blink sequence, whereas artefacts will blink only once. The discovered nova popped out very clearly.

Our sincere congratulations to George and we hope he will have further successes in his study of Messier 31. This shortened version appears in this Circular in addition to a longer article in the February BAA Journal so we can encourage other potential patrollers to consider searching M31 and M33 for extra-galactic novae.

Guy@tahq.demon.co.uk

ECLIPSING BINARY NEWS - FEBRUARY 2016

DES LOUGHNEY

New Minima

My attention has been drawn to a facility on the 'Atlas of O-C Diagrams of Eclipsing Binaries' website < *as.up.krakow.pl* >

Under the menu heading of New Minima there is a form for the input of new minima which is reproduced below. It will be noted that the required time is in the Heliocentric Julian Date format. There is a box to record error. I would welcome comments on how the error should be calculated for visual observation. There is no DSLR 'Type of Observation'. I hope the form can be amended to include this type.

The form does not specify a minimum number of visual observations which will allow a reasonable estimation of the moment of minimum. The usual assumption is that the minimum number of observations is 10, with five on either side of the minimum.

The Longest Period of an Eclipsing Binary

An eclipsing binary,TYC 2505-672-1, an analogue of Epsilon Aurigae, has been discovered with a period of 69.1 years, and a near total eclipse lasting about 3.45 years. The EB lies in Leo Minor. The eclipse has a depth of about 4.5 magnitudes from 11 to 15 magnitude. The last eclipse took place in 2011-2014. The next eclipse is scheduled between 2080 and 2083. The details of the system are presented in a draft paper(1).

Amateurs made a contribution to the paper. Coordinated by the AAVSO, measurements were made during the last eclipse. Data has been gathered over a period of 120 years, including the eclipse in the 1940s, through analysis of a digitized version of the Harvard astronomical plate collection. This allows the study of objects on a century-long time scale. To date, over 100,000 plates have been scanned.

A Five Star Doubly Eclipsing Star System

Astronomers at the Open University have discovered the first quintuple star system containing two eclipsing binary stars(2). The system was detected using archived data from the SuperWasp project.

The light curve of the new quintuple system, designated as 1SWASP J093010.78+533859.5, initially revealed the presence of a contact eclipsing binary. Contact binaries are quite common, but this particular system is notable because its orbital period - the time the two stars take to complete one orbital cycle - is so short, just under six hours.

Then it was spotted that the light curve contained some additional unexpected eclipses, and the data were reanalysed to reveal a second eclipsing binary at the same location on the sky. The new binary is detached - its component stars are well separated by a distance of about 3 million km, or about twice the size of the Sun - and it has a longer orbital period of one and a third days.

ZZ Boo

This bright eclipsing binary is one of our priority systems and easy to find as it is near Arcturus. In our list it is an EA system and this is the description in the GCVS database as well as the AAVSO's. However the Krakow database lists it as an EW/KW system, implying that it has quite a different light curve compared with an EA system. The primary and secondary partial eclipses are of equal depth, from 6.8 magitude to 7.5. The period is 4.9917633 days which makes it an akward system to profile. As it is so near a whole number of days, eclipses can be unfavourable for a long period of a time. It does seem to be worth studying in order to find out how the system should be classified.

References

1. Astronomical Journal, in press, <*arxiv.org/abs/1601.00135*>.

2. "The doubly eclipsing quintuple low-mass star system 1SWASP J093010.78+533859.5", Astronomy & Astrophysics, Volume **578**, A103 (2015)

desloughney@blueyonder.co.uk

NEW UTILITIES FOR VARIABLE STAR OBSERVERS

JAMES SCREECH

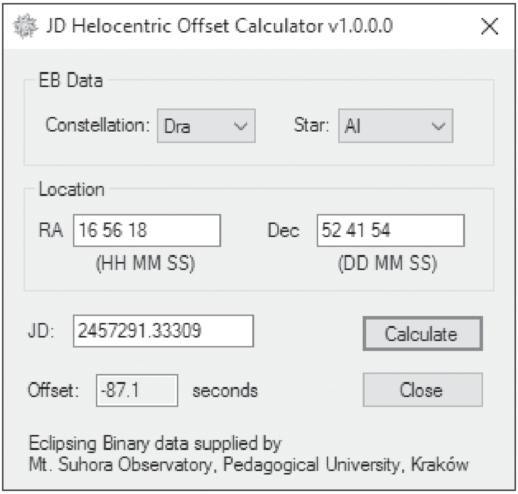
I recently joined the BAA variable star section, as I wanted to perform some worthwhile science instead of just "doing" astronomy for my own enjoyment, and I started looking for software utilities that would help with my observations. The utilities that I found had limitations, so I decided to write my own, which are documented in this article. If you would like a copy of one or more of the applications, my contact details are given at the end of the article.

My main area of interest is eclipsing binaries, so I make no apologies about the fact that three of these four applications are purely for observers of eclipsing binary stars. All four applications make use of a linear elements database file from the Mount Suhora Astronomical Observatory, part of the Cracow Pedagogical University, who have kindly given me permission to use their data and to distribute it freely with my applications.

Heliocentric JD Offset

The first application, Heliocentric Julian Date (HJD) Offset (see Fig.1page 8), calculates the JD to HJD offset required when analysing photometric images in AIP4Win. If the star you are observing is an eclipsing binary in the Mount Suhora database then select it using the drop down list boxes. For other stars, enter their coordinates in the appropriate

Figure 1: Heliocentric JD Offset



text boxes. Then enter the Julian date of the observation and click the "Calculate" button. The difference between the Julian date and heliocentric Julian date is calculated by the application and displayed, and can then be copied into the appropriate box in AIP4Win.

Binary Eclipse Timer
(see Figure 2 opposite)
The second application, Binary Eclipse Timer, estimates the time of mid eclipse of an eclipsing binary from an observer's data file written in the BAA database submissions format. The application fits a least squares polynomial curve to the data, and then estimates the time of mid eclipse from this curve. The level of polynomial used can be adjusted by the user. If the eclipsing binary is in the Mount Suhora database, the application will also display the predicted time of mid eclipse (primary eclipses only), so that your observations can be compared to the predictions.

The curve fitting works best if only the time period covering the eclipse is included in the data file, so it may be necessary to remove some data from the file before using it in this application. You may need to experiment to get the best curve fit.

Phase Calculator **(see Figure 3 page10)**
The third application, Phase Calculator, is to assist in the planning of eclipsing binary observation sessions; it calculates the predicted phase for a given night. The predictions are filtered to show only the stars visible from your location that meet criteria that you specify.

To use the Phase Calculator, enter (1) your observing site's latitude and longitude (negative for west / south), (2) the date you want the predictions for, (3) the minimum altitude of the star and (4) the minimum distance you want the Sun to be below the horizon. Predictions will be made on the hour, for every hour that the Sun is further below the horizon than the entered value. Only stars that are above the chosen minimum altitude, at some time during the night, are displayed. A horizontal line in the prediction indicates that the star is too low at this time.

The stars displayed can be filtered on several criteria by clicking on the star filter button. Here you can select (1) a magnitude range of the stars displayed, (2) a period range and (3) the types (EA, EB and EW) that you are interested in. The predictions can be printed, or saved to a tab delimited file, or to a comma delimited file, as required, by clicking the appropriate button.

The fourth application, Phase Diagram, plots a double phase diagram for an eclipsing

(Continued on p.10)

Figure 2: Binary Eclipse Timer

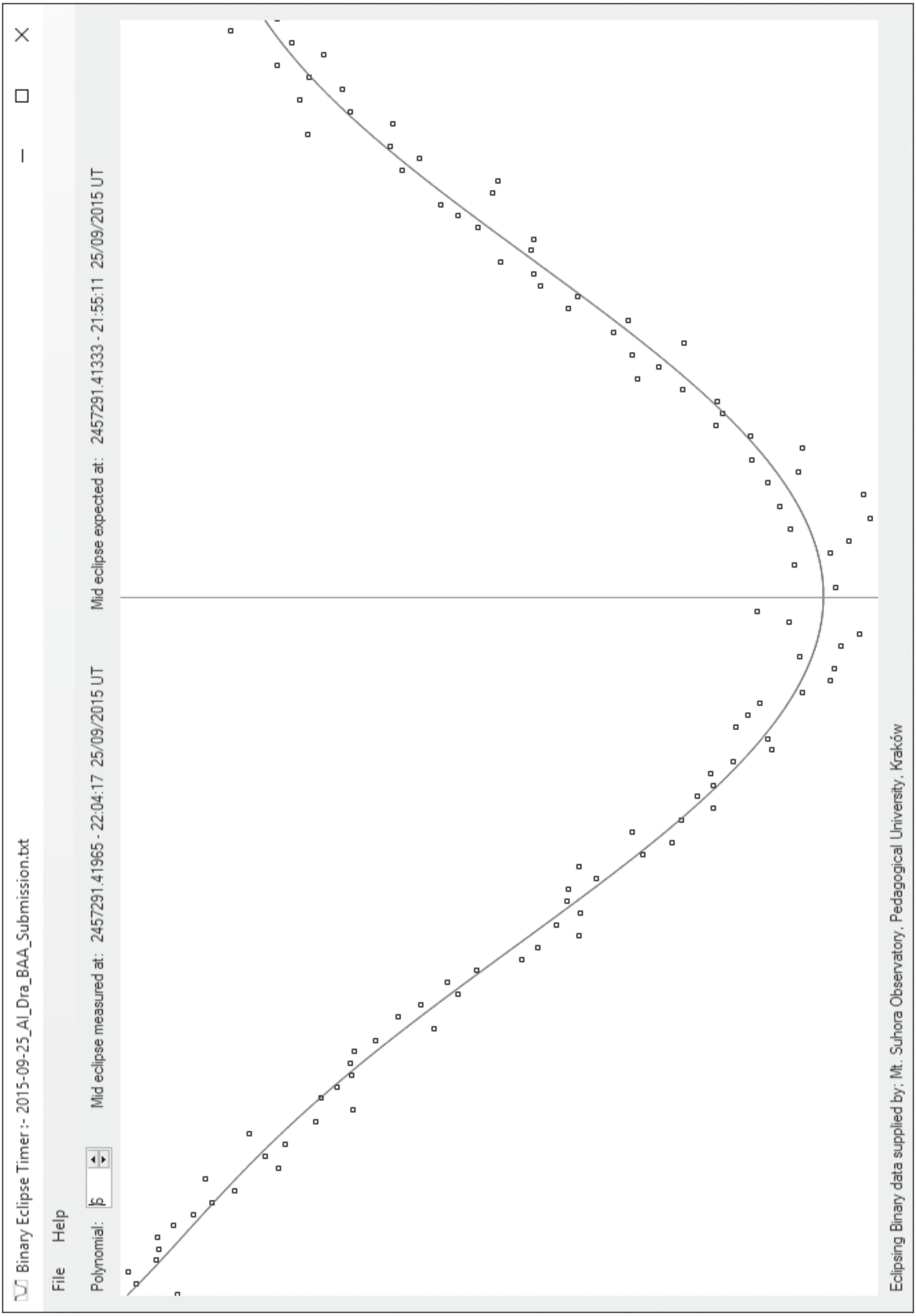
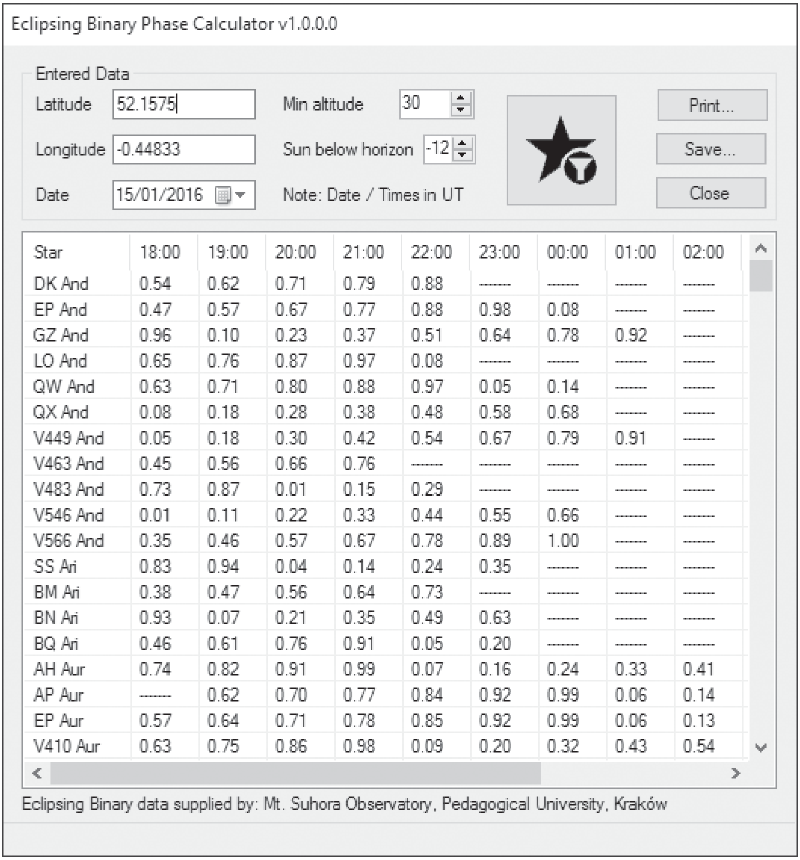


Figure 3 Eclipsing Binary Phase Calculator



Star	18:00	19:00	20:00	21:00	22:00	23:00	00:00	01:00	02:00
DK And	0.54	0.62	0.71	0.79	0.88	-------	-------	-------	-------
EP And	0.47	0.57	0.67	0.77	0.88	0.98	0.08	-------	-------
GZ And	0.96	0.10	0.23	0.37	0.51	0.64	0.78	0.92	-------
LO And	0.65	0.76	0.87	0.97	0.08	-------	-------	-------	-------
QW And	0.63	0.71	0.80	0.88	0.97	0.05	0.14	-------	-------
QX And	0.08	0.18	0.28	0.38	0.48	0.58	0.68	-------	-------
V449 And	0.05	0.18	0.30	0.42	0.54	0.67	0.79	0.91	-------
V463 And	0.45	0.56	0.66	0.76	-------	-------	-------	-------	-------
V483 And	0.73	0.87	0.01	0.15	0.29	-------	-------	-------	-------
V546 And	0.01	0.11	0.22	0.33	0.44	0.55	0.66	-------	-------
V566 And	0.35	0.46	0.57	0.67	0.78	0.89	1.00	-------	-------
SS Ari	0.83	0.94	0.04	0.14	0.24	0.35	-------	-------	-------
BM Ari	0.38	0.47	0.56	0.64	0.73	-------	-------	-------	-------
BN Ari	0.93	0.07	0.21	0.35	0.49	0.63	-------	-------	-------
BQ Ari	0.46	0.61	0.76	0.91	0.05	0.20	-------	-------	-------
AH Aur	0.74	0.82	0.91	0.99	0.07	0.16	0.24	0.33	0.41
AP Aur	-------	0.62	0.70	0.77	0.84	0.92	0.99	0.06	0.14
EP Aur	0.57	0.64	0.71	0.78	0.85	0.92	0.99	0.06	0.13
V410 Aur	0.63	0.75	0.86	0.98	0.09	0.20	0.32	0.43	0.54

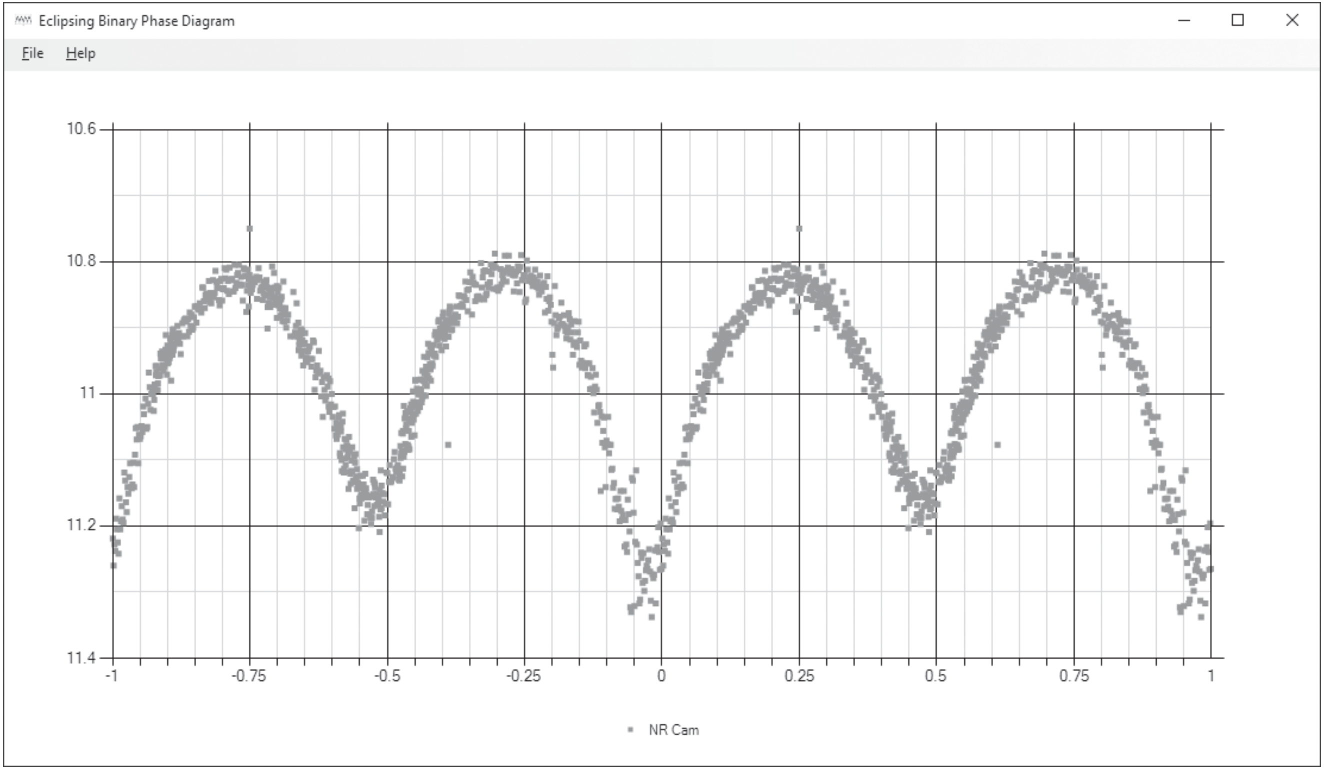
binary star. Phase Diagram (like Eclipse Timer) reads observational data written in the BAA database submission format. Note that the Phase Diagram application will currently only work with stars that are in the Mount Suhora Astronomical Observatory database.

Use the “File : Add Data” menu to select one or more observation files. The selected files are read, and the phase is calculated from the database for each observation, and then plotted on the graph. The menu can be used again to add more data to the same plot, or to plot a diagram for another star. To do this, use the “File : New” menu first. The resulting phase diagram can be saved as an image or sent directly to a printer using the appropriate menu items.

The four applications described above are available free to anyone who would like a copy. Although they are free, they are not open source and I retain copyright of the code. The usual provisos apply: for example, I accept no responsibility for any loss or damage resulting from their use, and they are provided “as is” with no guarantee that they are fit for a particular purpose. They should run on any version of Windows from

(Continued from p.10) Windows XP to Windows 10. They all require the ".net framework 4.0" which will probably already be installed on most Windows computers, however if it is not, it can be downloaded from the Microsoft web site.

Figure 4 Phase Diagram



jamestscreech@aol.com

R AQUILAE REVISITED

John Greaves

Abstract
The BAAVSS visual data[1] for R Aquilae from 1997 to 2015 were used to assess the evolution of its period in modern times. Times of maxima were derived from the data, as well as a period search using Phase Dispersion Minimisation algorithm.

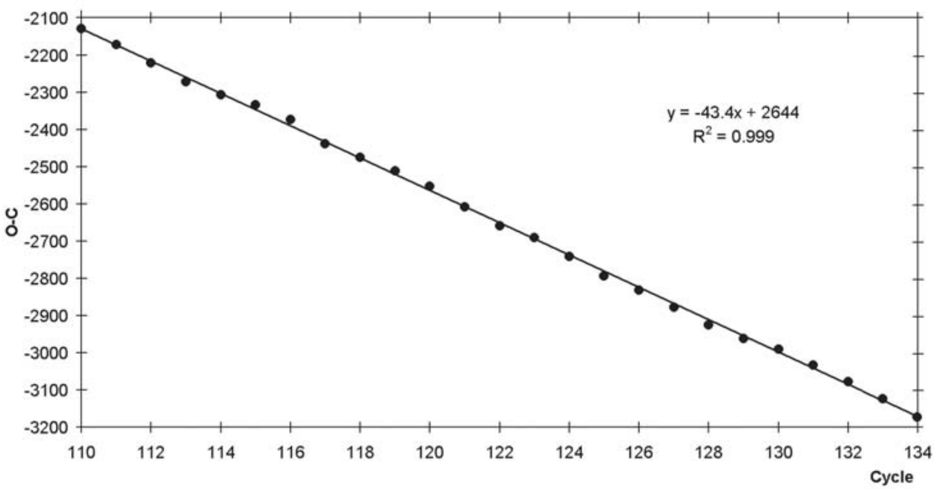
Introduction
In 1997, in my first attempt at an astronomical publication, I analysed the BAAVSS data from 1908 to 1997 for the Mira variable star R Aquilae in order to delineate its declining period (Greaves 1997, available on the BAA VSS website). The result in that paper was used to make a prediction of the period in future times, ending in a prediction of a period of around 270 days in 2010.

In the present paper, the visual data from 1997 to 2015 were obtained, and used to assess and illustrate how the periodicity had evolved since the publication of the 1997 paper. The results are (perhaps) fittingly described here, in the VSSC, where I published my first paper, in what is intended to be my last attempt at an astronomical publication.

Results
In the present paper, as in my 1997 paper, the base period of 315 days was used in the derivation of the O-C (observed minus calculated) diagram with the initial base epoch of JD 2418213. Comparison of the O-C diagram in the 1997 paper with Figure 1 (below) shows a distinct difference. In the earlier paper, the evolution of the discrepancy of observed maximum timing compared to base ephemeris calculated timing was best fit via a curved quadratic line: $y = -0.1871x^2 + 0.5402x + 20.011$
In the current analysis, the O-C diagram is readily fit with a linear fit. In fact very well fit by such: $y = -43.4x + 2644$

In O-C plots when a linear fit is achieved, and if that fit is a horizontal line, then the period

Figure 1: O-C diagram for R Aquilae from Cycle 110 to 134 (1997 to 2015) for an assumed base period of 315 days and a starting epoch of JD 2418213. Note the high significance of the "goodness of fit" value of R-squared (maximum possible value = 1) for a linear fit to the data.



utilised (called here the “test period”) in deriving the calculated (that is, predicted) maxima is an accurate one. Observed and calculated (predicted) maxima coincide to a good level of agreement. If the test period is not optimised then the plot remains linear, but slopes in one direction or another, depending on whether the period is too small or too large compared to reality, with the angle of slope increasing in scale with how inaccurate the test period is. Some plots do not fit well even with a valid test period, that is, there can be a goodly amount of scatter around any mean representative period. This is especially somewhat characteristic of Mira variables that typically have periods erratic by around plus or minus ten days or so.

When there is monotonic period change, that is when the period is either constantly declining or increasing, for many cycles the O-C plot will be arced, the amount of arcing correlating with the degree of period change. Period scatter can lead to short arcs, but a long enough run of data reveals these temporary random excursions as they will often change direction of arcing such that there is no true period change, just a stochastic drift for a short while.

Taking data up to 1997 such a curve (the quadratic) could be found in the data of R Aquilae, denoting a long running mean period change of 0.4 days decline per cycle.

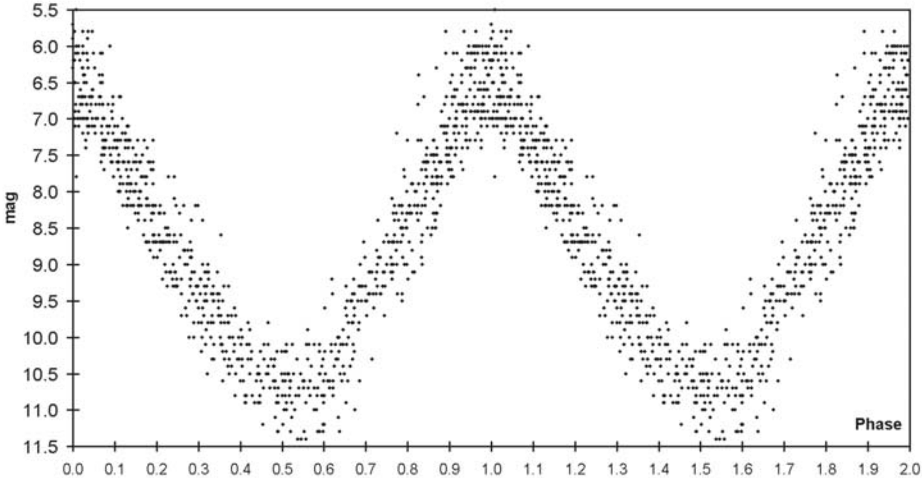
However, taking data only from 1997 shows a linear fit, albeit sloped (as the test period of 315 days is no longer representative). That means R Aquilae is best fit by a representative mean period from 1997 onwards. The switch over will not have been in 1997. The time of the change is too recent to be certain of, at present, from plotting of data, but the period most likely stopped declining somewhere between 2000 and 2010, possibly within the last decade.

If the “intermaximal intervals”, that is the times between consecutive maxima, are taken, then since 1997 the respective “periods” as delineated by those intervals lead to an average period of 271.9 days, a median period of 272.0 days, and a standard deviation of 9.0 days upon that. The minimum “period” was 250 days and the maximum one 280, with jumps in “period” from consecutive maxima being as much as 25 days at a time, but often only a few days, with the overall average being around 10 days.

Interestingly, when the raw data were used in a period search using the Phase Dispersion Minimisation method a period of 271.5 days was found. The data folded on a period of 272 days, as an illustrative phase diagram, are shown in Figure 2 (page 14). Evidently the star has settled down to being a normal Mira, and not changed its nature to a lower amplitude SemiRegular variable; neither SRa (often as regular in shape and period as a Mira but of lower amplitude) nor SRb (usually more erratic in lightcurve shape due to 2 or more periods interfering), nor a completely irregular long period variable, nor for that matter ceased pulsating entirely.

The peak for this period was symmetric in shape and narrow, suggesting little if any significant period drift throughout the run of the data. Two quite small peaks could be found at much shorter periods, but one turned out to be 136 days (ie half of 272, and thus an harmonic effect) whilst the other turned out to be around 156.5 or so days. An “alias” period within a period search can result from a signal superimposed by incidental timings in the observing regime for an object. The most common one is often referred to as the “annual alias”, a shadow of the annual routine of both the sky and the observer. A period of around 1/156.5 days turns out to be equal to 1/272 + 1/365 (that is the reciprocal of the other small peak equals the sum of the reciprocal of the true period plus the sum of the

Figure 2: A phase diagram derived from period searching upon the raw data and based upon 272 days. The average cycle is shown repeated (that is two cycles) for clarity of image.



reciprocal of one year, when all are expressed in days). This period is therefore highly likely the annual alias and an artefact.

Conclusion

R Aquilae joins several other period changing Mira (eg R Hya and T UMi) in ceasing monotonic period change. This is likely to have occurred in the past decade, and contrary to the predictions in Greaves 1997 it never really quite reached a representative period of 270 days at the end of its decline.

It currently resembles a normal Mira with typical amplitude of around 4 to 6 magnitudes, with typical scatter for a Mira, and is reasonably well fit by a period of 272 days with a scatter of around ten days either side of that (which is also pretty typical for a Mira). Figure 2 highlights this point.

As stated above, this change is relatively recent and with such stars the continuance of behaviour in one set pattern is not always assured. Continued visual observations throughout the rest of the decade if not into the next will be required to be able to assess whether this cessation of period change is in fact real, and not apparent; and even if shown to be real, as to whether it is a temporary cessation, or the new long term behaviour and/or nature of this star.

An investigation for future analysts to perform.

Acknowledgements

I thank Gary Poyner, Dave McAdam and Roger Pickard who in making available to me BAAVSS observational data about two decades ago can be deemed ultimately responsible for much of the diverse subsequent analyses. Yes, it is all their fault. It is good to see that nowadays BAAVSS data is readily available for anyone to use via the online interface.

References

1. BAAVSS online database:*http://britastro.org/vssdb/*

2. J. Greaves, *Br. Astron. Assoc., Var. Star Sect. Circ.,* No. 94, p. 9 - 12, 1997
(available online at the BAAVSS website: *http://www.britastro.org/vss/00012a.html*)

Table 1: **Julian Dates of the derived times of Maxima used in the O-C plot in Figure 1**

CYCLE	JULIAN DATE	CYCLE	JULIAN DATE
110	2450727	123	2454268
111	2451007	124	2454531
112	2451272	125	2454795
113	2451537	126	2455072
114	2451816	126	2455072
115	2452104	127	2455340
116	2452380	128	2455608
117	2452630	129	2455886
118	2452908	130	2456172
119	2453187	131	2456444
120	2453460	132	2456715
121	2453720	133	2456984
122	2453985	134	2457260

WHAT IS GOING ON WITH QZ AURIGAE?

DAVID BOYD

QZ Aurigae is an eclipsing cataclysmic variable which experienced a nova outburst in 1964. The outburst was recorded on an objective-prism photographic plate taken in November 1964, but not measured until 1975 (Sanduleak 1975). A subsequent search through the Sonneberg plate archive found that the outburst had reached magnitude 6.0 (Gessner 1975). It subsequently faded with a t_3 time of 23-30 days, which classifies it as a fast nova, and eventually settled around magnitude 17. Since then the star has been relatively neglected and few observations have been reported in the literature.

In 1995 Campbell and Shafter reported multicolour CCD photometry of QZ Aur, performed between 1990 and 1992, in which they recorded 10 eclipses and found an orbital period of 0.3574961(5) days (8.58 hours). Further CCD photometry between November 2008 and January 2013 was reported by Shi and Qian in 2014. Their data provided a further 8 times of mid-eclipse. In 2012 Jonathan Kemp provided me with photometry of QZ Aur he had obtained in November 2009, with the 2.4m MDM telescope at Kitt Peak, from which I measured another mid-eclipse time. In total I now had 19 mid-eclipse times.

Using these 19 mid-eclipse times I calculated the following linear ephemeris for eclipses of QZ Aur where E is the cycle number:

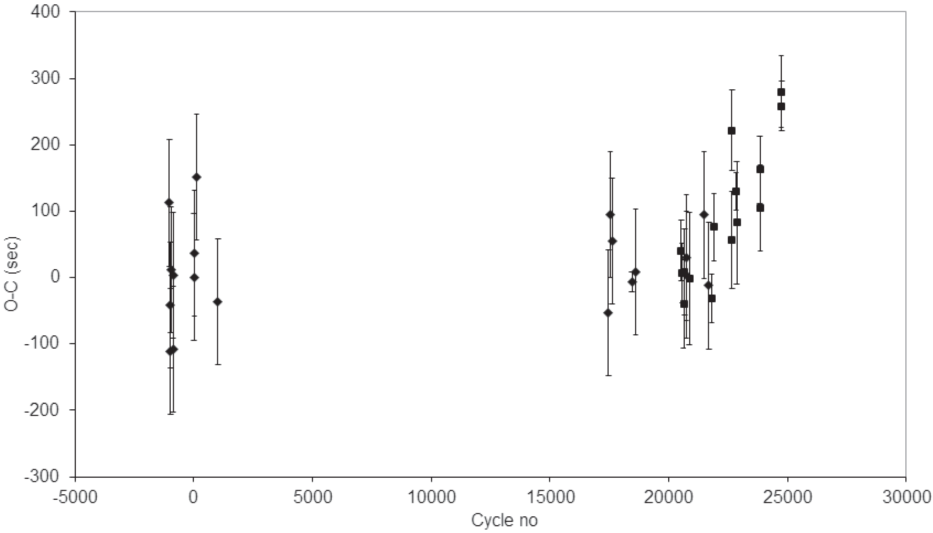
$$T_0\,(HJD/UTC) = 2448555.1594(3) + 0.35749587(2) * E \qquad (1)$$

This agrees with the ephemeris given by Shi and Qian who say that "the orbital period does not appear to be either increasing or decreasing with time". The data up to that point support this conclusion.

As part of a project to monitor the orbital periods of several eclipsing novae and novalike variables, I have observed 15 eclipses of QZ Aur since November 2011. These eclipses are typically about 1.5 magnitudes deep and are V-shaped and symmetrical with a rounded minimum. I measure the mid-eclipse time by fitting a parabola to the lower portion of the eclipse light curve. All times are converted to HJD/UTC.

Figure 1 shows an O-C plot of the apparent discrepancy between each Observed eclipse time and the time Calculated for that eclipse from the above ephemeris. The eclipses from Campbell and Shafter, Shi and Qian, and Kemp are marked by diamonds, and my eclipses by squares. I have increased the published errors on the Shi & Qian data, based on their actual scatter, to more accurately reflect their real uncertainty. Up to cycle 22000 (May 2013) the eclipses are consistent with the above ephemeris but after that there is a clear trend for eclipses to occur later than the predicted time, such that by January 2016 these are happening between 4 and 5 minutes later than predicted. A linear ephemeris for eclipses later than cycle 22000 has a period 0.3574964(2) days (46 milliseconds longer).
It is possible that the variation in O-C since 1990 could be interpreted as a progressive increase in the orbital period. Figure 2 shows the same data fitted with a quadratic

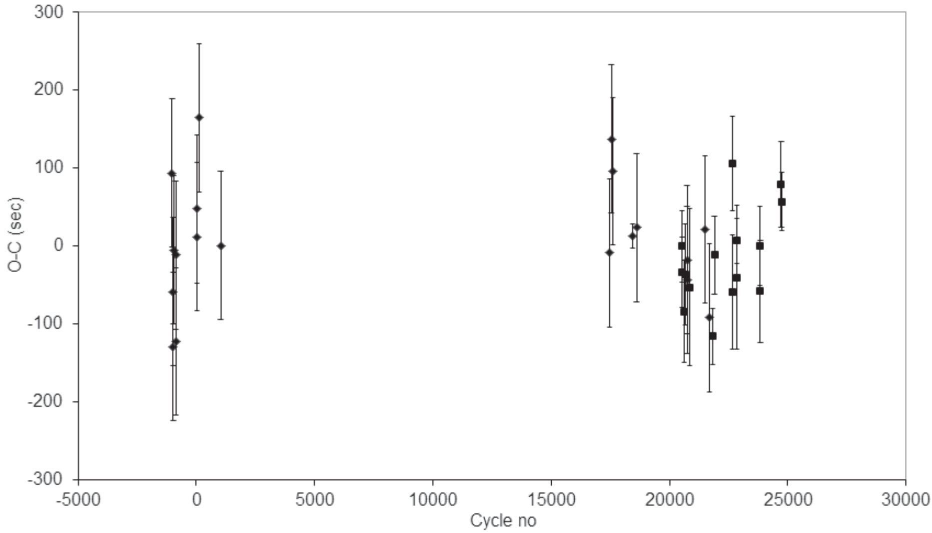
Figure 1: O-C plot for eclipses of QZ Aur with respect to the linear ephemeris in equation (1).



ephemeris which represents a steady increase in orbital period at a rate of 2.9 milliseconds/year. Statistically this is a less favoured solution, as the chi-squared probability for the quadratic solution is worse than that for two linear fits to the data before and after cycle 22000.

The physical process which might be causing this behaviour is unclear. Mass transfer

Figure 2: O-C plot for eclipses of QZ Aur with respect to a quadratic ephemeris.



from a less massive donor secondary to a more massive white dwarf would cause an increase in the orbital period. However Campbell and Shafter find a mass ratio for QZ Aur close to 1 indicating both components have similar mass. Only further observation will determine what the future holds for QZ Aur.

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davidboyd@orion.me.uk

THE NON VARIABILITY OF HD197311 DELPHINI

JOHN TOONE

Whilst undertaking a fruitless search for George Alcock's alleged 700 observations of HR Del, I found within my chart/sequence archive the original report from Patrick Moore on his belief that HD197311 (BD+18 4586) was variable. HD197311 was comparison star K (listed as mag 8.30) on the original BAA VSS chart for HR Del (Figure 1, page 18) drawn by VSS Director John Glasby.

Patrick's report (Fig 2, see page 19), prepared on his famous typewriter, listed his visual observations in 1969 and reasons for believing it to be variable. Patrick went so far as to announce his findings in IBVS385 (1969). Based upon Patrick's report other VSS observers monitored HD197311 and it was dropped as a comparison star. Peter Gill, Michael Ring and Keith Sturdy monitored it visually between 1969 and 1972 but only picked up

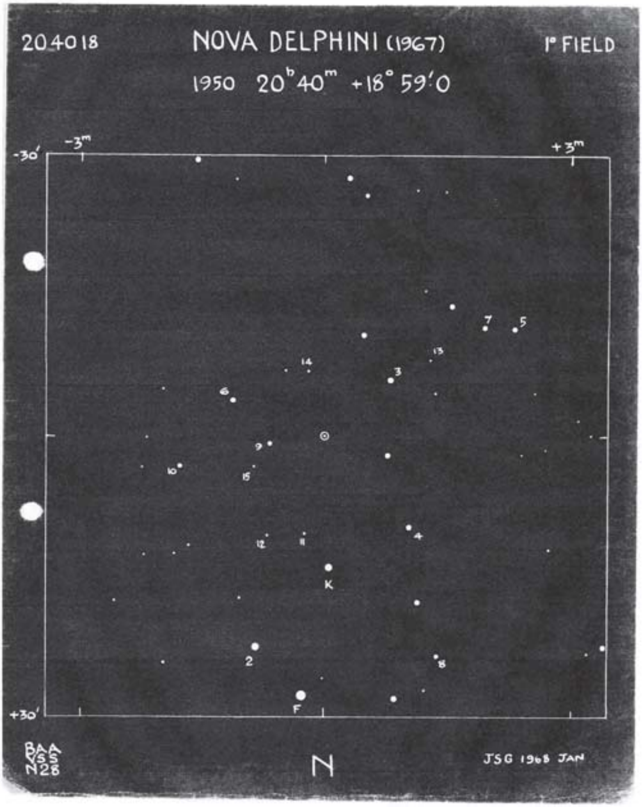

Figure 1: original BAA VSS chart for HR Delphini drawn by: ***John Glasby.***

small range (7.9-8.3) scatter. In IBVS578 (1971) Tate and Burke reported that photoelectric measures indicated no detectable variation. On account of Tate and Burke's report, HD197311 has been regarded as constant ever since.

Patrick had reported variation between 7.9 and 8.4 compared with comparison stars F, 2 and 3, using values of 8.5 for 3 and 8.6 for 2, because he considered 2 to be slightly fainter than 3.

The original sequence in the range 7.5 to 9.0 is given below together with modern photometry and B-V values:

Star	Mag	HD	Tycho	B-V
F	7.52	197275	7.60	+0.13
E	7.68	197473	8.02	+0.66
1	7.97	197682	8.00	+1.48
H	8.14	197518	8.25	+0.66
K	8.30	197311	7.83	+1.02
2	8.34	197229	8.56	+0.18
3	8.48	1973997	8.57	+0.08
4	8.81	197408	8.87	+0.26

There are a few notable facts illustrated by the above table. Firstly, the sequence seems to be in the correct order with the exception of K, which is clearly out of step. Secondly, the sequence has a wide colour range with four white stars, two yellow stars, one orange star and one red star. Finally, stars 2 and 3, which Patrick had difficulty with, are essentially the same brightness and colour.

The combination of an incorrect measurement within a wide colour range sequence

Figure 2: visual observations of HR Delphini in 1969 (*Patrick Moore)*

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BD + 18°4586 Delphini

This is the star marked K in the BAA sequence for HR Delphini. I found that my estimates were showing discrepancies, and by September I had tracked the trouble down to K, which is a late-type star. Unfortunately there is also the snag that 3 is brighter than 2 in the same sequence, though 3 is given as 8.5 and 2 as 8.3!

So far as I can make out, 3 (an early-type star) is right, and is constant; it is consistently above 2. Therefore I have gambled on it, and have used it as my standard for BD +18°4586. The estimates are interesting. I worked them back, using my comparisons of HR, 3, 2 and F, and then gave the magnitudes. Thereafter, 3 and 2 have been used, taking 3 = 8.5 and 2 = 8.6. When the lightcurve is plotted it seems to show a definite cycle of around 15 days, and a range of between 7.9 and 8.4, but it is much too early to come to any conclusions. I suggest that the star be watched. I may be wrong, of course; but all I can do is to give my results!

(All 12½in. x 72)
(except * = 8½in. x 72)

Date. 1969	GMT.	Class.	Magnitude, worked out from 3, 2 and F.
Aug.29	0030	3	8.1
Set.1	2015	1	8.3
Set.3	2100	1	8.3
Set.4	2200	5	8.3
Set.5	2200	3	8.0
Set.7	2300	1	7.9
Set.17	2010	4	8.2
Set.19	2200	2	8.2
Set.24	2330	3*	7.9
Set.30	2130	5	8.2
Oct.1	2240	3	8.2
Oct.4	2300	2*	8.1
Oct.5	2200	3	8.1
Oct.9	0130	3*	8.1
Oct.9	2140	1	8.1
Oct.10	1945	4	8.3
Oct.15	2350	1	8.4
Oct.19	2230	1	8.1 (4in.OG x 44)
Oct.27	1940	4	8.2
Oct.28	2230	5	8.2
Oct.29	2350	3*	8.0
Oct.30	2000	1	8.0
Nov.1	1820	1	7.9
Nov.8	2000	1	7.9
Nov.9	1900	3	7.9 (3in.OG x 36)
Nov.15	1900	2	8.0
Nov.16	1850	2	7.9
Nov.17	2320	5*	8.1
Nov.29	1750	2	8.1
Nov.30	1830	1	8.0
Dec.8	2050	3	8.1
Dec.10	2000	5	8.1
Dec.13	2000	3	8.0

Patrick Moore

(something I have canvassed against for many years) seems to have led Patrick to imagine some variation that was not present. Additionally, Patrick was using his 12.5" reflector on what were binocular stars which would have enhanced their colour differences. However, the range Patrick claimed to have seen was not large and he did after all conclude his report with the following words:

"I may be wrong, of course; but all I can do is to give my results."

Patrick was following one of the golden rules of visual observing; always record and report exactly what you see. Unfortunately on this occasion the apparent variation was not due to a variable star, but was merely a function of a discrepant multi-coloured sequence exacerbated by the use of an overly large instrument.

enootnhoj@btinternet.com

THE BAAVSS ECLIPSING BINARY PROGRAMME

The 'Max' and 'Min' magnitudes are all visual except where the 'Min' is followed by a 'p', in which case they are both photographic.

In the Eclipsing Binary Program list, the Period column is in days (d), the 'D' column gives the duration of the eclipse in hours. This is only well-defined for Algol type (EA) stars. 'EB' or 'EW' in this column indicates that the star is a Beta Lyrae or W UMa star.

The 'Chart' column gives the identifier or date of the latest version of the chart.

Beginner's Eclipsing Binaries

Star	RA	Dec	Max	Min1	Min2	Period (d)	D (h)	Chart
Beta Lyr	18 50	33 22	3.3	3.9	4.4	12.91	EB	328.01
Beta Per	03 08	40 57	2.1	2.2	3.4	2.87	10	327.01
RZ Cas	02 49	69 38	6.2	6.3	7.7	1.2	5	236.02
U Cep	01 02	81 03	6.8	6.9	9.4	2.49	9	279.01
W UMa	09 44	55 57	7.8	8.4	8.5	0.33	EW	248.01

Priority Eclipsing Binaries

Star	RA	Dec	Max	Min1	Min2	Period (d)	D (h)	Chart
OO Aql	19.48	9.18	9.2	9.8	9.9	0.51	EW	1984Dec23
AR Aur	05 18	33 46	6.2	6.7	6.8	4.13	7	283.01
EO Aur	05 18	36 38	7.6	7.9	8.1	4.07	12	283.0
IM Aur	05 16	46 25	7.9	8.1	8.5	1.25	6	1972Feb04
LY Aur	05 30	35 23	6.7	7.3	7.4	4	EB	283.01
ZZ Boo	13 56	25 55	6.8	7.4	7.4	4.99	7	252.01
TV Cas	00 19	59 08	7.2	7.3	8.2	1.81	8	1982Aug16
TW Cas	02 46	65 44	8.3	8.4	9	1.43	5	237.01
U CrB	15 18	31 39	7.7	7.7	8.8	3.45	12	254.01
RS CVn	13 11	35 36	7.9	8.2	9.1	4.8	13	253.01
V367 Cyg	20 48	30 17	6.7	7.2	7.6	18.6	EB	1986Jul06
Z Dra	11 46	72 15	10.8	11	14.1	1.36	5	1993Jan10
TW Dra	15 34	63 54	7.3	7.4	8.9	2.81	11	274.01
AI Dra	16 56	52 42	7.1	7.2	8.1	1.2	5	284.01
BH Dra	19 04	57 27	8	8.1	8.6	1.82	5	285.01
S Equ	20 57	05 05	8	8.1	10.1	3.44	11	286.01
68u Her	17 17	33 06	4.7	4.9	5.4	2.05	14	1971Aug27
Z Her	17 58	15 08	7.3	8.2	8.2	3.99	11	1972Feb06
AR Lac	22 09	45 45	6.1	6.4	6.8	1.98	7	1971Feb13
UV Leo	10 38	14 16	8.9	9.5	9.6	0.6	3	1987Nov
V566 Oph	17 57	04 59	7.5	7.9	8	0.41	EW	1972Jun11
EE Peg	21 40	09 11	6.9	7.1	7.5	2.63	6	245.01
IQ Per	04 00	48 06	7.7	7.9	8.7	1.74	5	246.01
U Sge	19 19	19 37	6.5	6.7	9.3	3.38	14	287.01

Star	RA	Dec	Max	Min1	Min2	Period (d)	D (h)	Chart
Lambda Tau	04 01	12 29	3.4	3.9	3.5	3.95	26	TB 1993
RW Tau	04 04	28 08	8	8.1	11.2	2.77	9	1984Dec18
HU Tau	04 38	20 41	5.9	5.9	6.7	2.06	7	247.01
TX UMa	10 45	45 34	7.1	7.1	8.8	3.06	9	288.01
Z Vul	19 22	25 34	7.3	7.6	8.9	2.45	11	255.01

Other Eclipsing Binaries

Star	RA	Dec	Max	Min1	Min2	Period (d)	D (h)	Chart
TW And	00 03	32.51	8.8	8.9	10.9	4.12	13	AAVSO122901
AD And	23 37	48.40	10.9	11.6	11.6	0.99	E B	1984Dec22
IU Aur	05 28	34 47	8.2	8.7	8.8	1.81	E B	1984Dec24
SX Aur	05 12	42.10	8.4	8.9	9.1	1.21	E B	1984Dec23
BM Cas	00 55	64.05	8.8	9	9.3	197.28	E B	1986Jul05
DO Cas	02 41	60 33	8.4	8.6	9	0.68	E B	1986Jul05
EG Cep	20 16	76 49	9.3	9.6	10.2	0.54	EB	AAVSO0801
GK Cep	21 31	70 49	6.9	7.4	7.4	0.94	E B	1971Dec02
V448 Cyg	20 06	35 23	7.9	8.4	8.7	6.52	E B	1986Jul06
V477 Cyg	20 05	31 58	8.5	8.7	9.3	2.35	4	1972Feb05
RX Her	18 31	12 37	7.3	7.7	7.9	1.78	6	1972Jun12
SW Lac	22 54	37 56	8.5	9.3	9.4	0.32	E W	1987Nov
AP Leo	11 05	05 09	9.3	9.9	9.9	0.43	E W	1987Nov
TZ Lyr	18 16	41 07	10.6	10.8	11.3	0.53	E B	1987Nov
V505 Mon	06 46	02 30	7.2	7.6	7.7	53.78	E B	1971Aug22
CD Tau	05 18	20 08	6.8	7.3	7.3	3.44	7	1972Feb04

Low Amplitude Eclipsing Binaries

Here is a selection of ten low amplitude eclipsing binaries. These will have been neglected by visual observers because of their low amplitude. They are, however, suitable targets for DSLR photometry. Charts and comparisons can be obtained by contacting the BAA Eclipsing Binary Secretary.

Star	RA	Dec	Max	Min1	Min2	Period (d)	Class
AO Cas	0.18	51.26	6.102	6.3	6.3	3.5	EW
YZ Cas	0.46	74.59	5.653	6.05	5.8	4.5	EA/DM
CC Cas	3.14	59.34	7.15	7.25	7.25	3.4	EB/DM
CQ Cep	22.37	56.54	8.87	9.37	9.27	1.6	EB/DM/WR
CW Cep	23.04	63.24	7.67	8.07	8.07	2.7	EA/DM
VW Cep	20.37	75.36	7.38	7.78	7.68	0.3	EW/KW
AH Cep	1.35	70.58	6.88	7.08	7.08	1.8	EB/DM
V1425Cyg	21.11	55.20	7.73	8.13	8.03	1.3	EB/KE
AW UMa	11.30	29.58	6.83	7.03	7.03	0.4	EW/KW
V1061Tau	4.59	24.30	8.03	8.43	8.33	1.4	E B

ECLIPSING BINARY PREDICTIONS – WHERE TO FIND THEM

Des Loughney - *desloughney@blueyonder.co.uk*

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

http://www.britastro.org/vss/dpredict.html

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

The best source for predictions for Eclipsing Binaries is the Mt. Suhora Astronomical Observatory, Cracow Pedagogical University website (known as the Krakow website)at:

http://www.as.up.krakow.pl/o-c/index.php3

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

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

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

http://www.konkoly.hu/IBVS/IBVS.html

Although the Krakow website lists the depth of eclipses it does not list the actual V magnitudes at maximum and minimum. For an indication of these magnitudes you will need to visit the 'General Catalogue of Variable Stars' website at:

http://www.sai.msu.su/groups/cluster/gcvs/gcvs/

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

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

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

The **deadline for contributions** to the next issue of VSSC (number 168) will be 7th May 2016. All articles should be sent to the editor (details are given on the back of this issue).

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SECTION OFFICERS

Director
Roger D Pickard
3 The Birches, Shobdon, Leominster,
Herefordshire HR6 9NG
Tel: 01568 708136
Email: *roger.pickard@sky.com*

Secretary
Bob C Dryden
21 Cross Road,
Cholsey,
Oxon, OX10 9PE
Tel: 01491 652006
Email: *visual.variables@britastro.org*

Chart Secretary
John Toone
Hillside View, 17 Ashdale Road,
Cressage, Shrewsbury, SY5 6DT.
Tel: 01952 510794
Email: *enootnhoj@btinternet.com*

Binocular Secretary
Shaun Albrighton
4 Walnut Close, Hartshill,
Nuneaton,Warwickshire, CV10 0XH
Tel: 02476 397183
Email:
shaun@albrighton1.wanadoo.co.uk

Nova/Supernova Secretary
Guy M Hurst
16 Westminster Close, Basingstoke,
Hants, RG22 4PP
Tel and Fax: 01256 471074
Email: *Guy@tahq.demon.co.uk*

Eclipsing Binary Secretary
Des Loughney
113 Kingsknowe Road North,
Edinburgh EH14 2DQ
Tel: 0131 477 0817
Email: *desloughney@blueyonder.co.uk*

Database Secretary
Andy Wilson
12 Barnard Close, Yatton,
Bristol, BS49 4HZ
Tel: 01934 830 683
Email: *andyjwilson_uk@hotmail.com*

Recurrent Objects Co-ordinator
Gary Poyner
67 Ellerton Road, Kingstanding,
Birmingham, B44 0QE.
Tel: 07876 077855
Email: *garypoyner@blueyonder.co.uk*

Circulars Editor
Janet Simpson
Goatfield Cottage, Furnace, Inveraray,
Argyll, PA32 8XN
Tel: 01499 500234
Email: *batair@hotmail.co.uk*

Webmaster
Gary Poyner
(see above)

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