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# Variable Star Section Circular

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## Cover Picture

Michael Woodman

Co-discoverer of 1946 outburst of T CrB  
*Photograph. Jeremy Shears*

## From the Director – *Jeremy Shears*

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After a succession of clear nights right at the beginning of January, the weather has taken a downhill trajectory ever since, at least for me. The predominant weather has been rain, interspersed with occasional snow. Surely it can't go on like this. I am sure we are all hoping for better times ahead in 2026. Which reminds me to draw your attention to the Variable Star of the Year 2026, which is **W Ursae Majoris**. An article by Des Loughney about this eclipsing binary appears in the 2026 BAA *Handbook* and online here: <https://britastro.org/vss/WUMaVSOTY.pdf>

With Spring approaching, we have the Winchester Weekend to look forward to in April. This year is the 60<sup>th</sup> anniversary and features two VSS speakers: Robin Leadbeater and John Toone. At the time of writing, a few tickets were still available. After that, if you decide you wish to attend, you might check with the BAA Office to see if there are any cancellations. I shall take the VSS display boards so if you have any material, please bring it along with you.

Several other meetings in the near future include talks with a variable theme. Richard Sargent will talk about variable nebulae at the BAA meeting in London on Wednesday 25 March. I shall be speaking about the first VSS Director, John Ellard Gore, at the BAA Historical Section meeting on Saturday 9 May at the Sherwood Observatory, Sutton-in-Ashfield, Nottinghamshire. And Gary Poyner will share his thoughts on VS observing in an urban environment at the BAA Spring Meeting in Leicester on Saturday 22 May.

Congratulations to Ian Sharp who was presented with the BAA Steavenson Award at the December 2025 meeting held in London. This is awarded to a member who has made an outstanding contribution to observational astronomy and Ian has been very active in variable star photometry for several years. He is especially known for his collaborative work on eclipse time variations in post common envelope binaries, with the work having been published in *Monthly Notices* and the BAA *Journal*.



*Ian Sharp at the December 2025 BAA meeting in London*

Congratulations also to Prof. Ingrid Pelisoli of the University of Warwick for receiving the Fowler Award of the Royal Astronomical Association. We were honoured to have Ingrid as keynote speaker at the VSS meeting in Northampton last year.



*Prof. Ingrid Pelisoli*

Talking of Section meetings, we are already planning our next one on 16 October 2027 in York. Whilst it might seem odd to be planning this soon, I am keen we maintain our biennial schedule and venues are already getting booked up (plus, it can become quite difficult to find a free slot in the busy BAA meetings schedule). The Section Officers and I were keen that we hold a meeting further north, making it a little easier for participants from northern England and Scotland to attend. York is, of course, well served by public transport. More details nearer the time.

As some of you know, I retired from full time employment last summer. One of my new activities is as a volunteer at Jodrell Bank and one of the perks is getting to see new exhibitions when they open at the visitors' centre. The current exhibition is *Cosmic Threads*. As part of the celebrations to mark the 80<sup>th</sup> anniversary of Jodrell Bank, the public was invited to participate in a community quilt project. Over 230 quilt squares were crafted, allowing 10 individual quilts to be made. The Lovell Telescope is, of course, often featured in the designs, but there are also many astronomical objects such as planets and galaxies. As a variable star enthusiast, my personal favourite is an artistic impression of the recurrent nova, RS Ophiuchi, complete with its binary star and white dwarf accretion disc – as shown in the vignette of one of the quilts below. I subsequently discovered that this square was contributed by Rebecca Forster, daughter of Prof. Tim O'Brien (Associate Director of the Jodrell Bank Centre for Astrophysics).

*Cosmic Threads* runs until March 27 at the Jodrell Bank Centre of Engagement. Do take the opportunity to visit if you can, though it is anticipated that the quilts will later be incorporated into the permanent exhibition.



*Part of one of the Jodrell Bank Cosmic Thread quilts with one panel depicting RS Oph*

Finally, readers will be saddened to note the death of Michael Woodman (1930 – 2026) on February 10, just 80 years and a day after his independent discovery of the last eruption of T CrB at the age of 15. Many of you had the opportunity to meet Michael when he was guest of honour at the January 2025 meeting of the BAA when I had the privilege of presenting him the Charles Butterworth Award. Michael was a true gentleman, modest yet highly inspirational. It is a great honour to have known him. I have conveyed condolences on behalf of the VSS to his sons and broader family.

# Three Pulsating Variables; TW Aur, RV Cam and V770 Cas

Shaun Albrighton

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**Provisional analysis of three under observed pulsating variables, TW Aur, RV Cam and V770 Cas. TW Aur has a main period of 145.5d together with a longer period of 1309d, and hints of additional shorter periods. RV Cam shows no indication of the 101d period listed in VSX, but has long periods of 863d and 1,900d. V770 Cas does not show any obvious periods, and is probably correctly listed as Lb.**

## Introduction

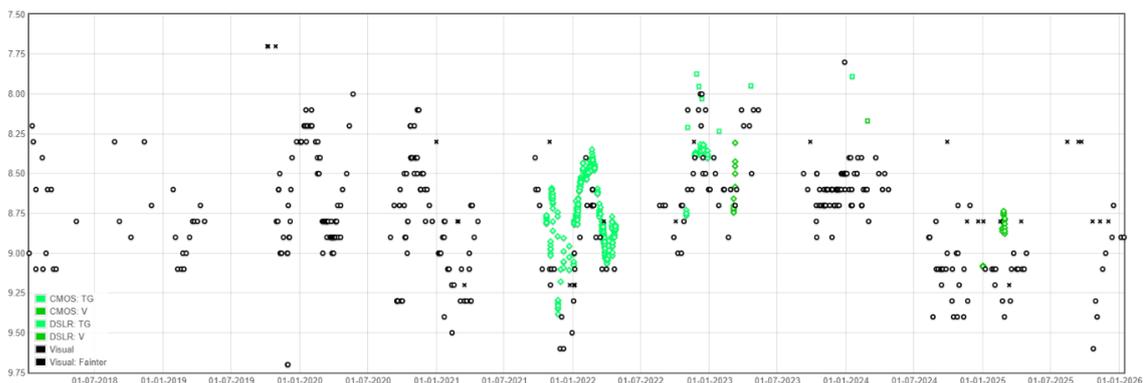
In 2017 a gap in the pulsating programme of the BAAVSS was identified for stars suitable for 70mm+ binoculars or small telescope. As a result, a number of additional variables were identified for which there were only a sparse number of observations listed in the AAVSO database. What follows is a provisional analysis of three of these variables.

## TW Aur

TW Aur was discovered by Annie Jump Cannon in 1908. VSX [1] lists the star as a SRb variable, Spec M5III, period 150d, range 7.4 – 9.5V. The GCSV team [2] highlight that the mean period varies with a period of 1370d.

BAAVSS observations since 2018 are plotted below. Both the main and secondary periods are clearly visible and yield an extreme range visually of 8.0 – 9.6. The short series of CCD observations confirm visual observations made at the time. Analysing the observations in the AAVSO Vstar program [3], confirm a main period of 145.5 d together with a longer period of 1309d. Additional shorter periods of 94.6d and 107.6d are also hinted at.

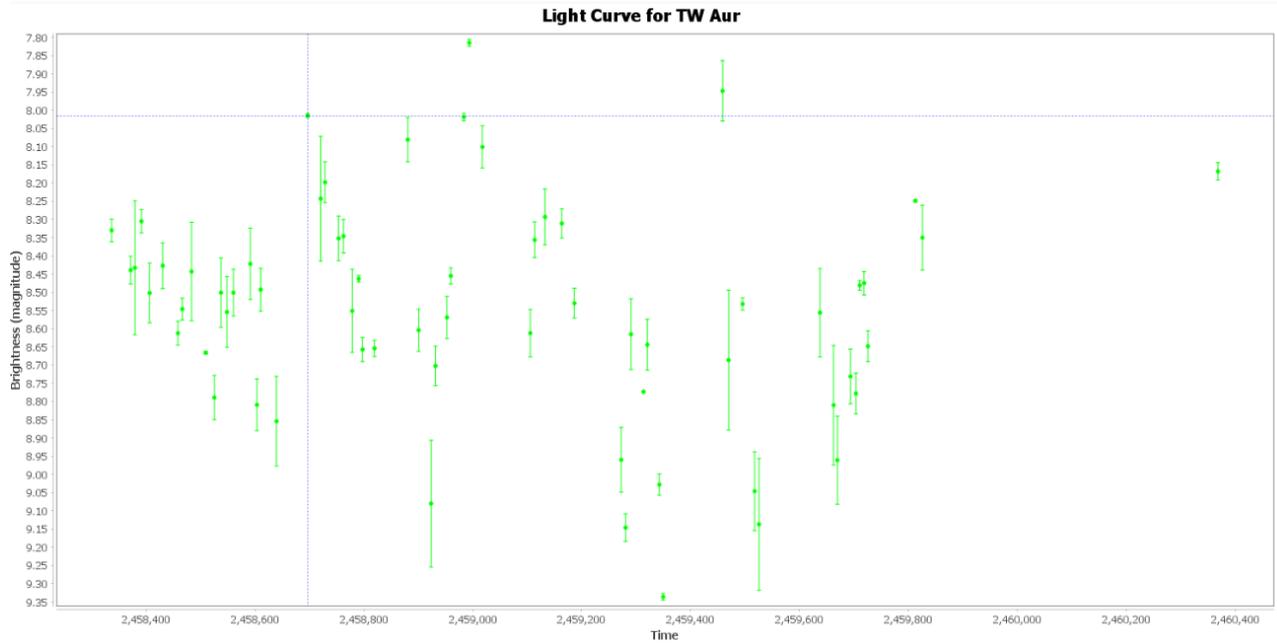
Light Curve for TW Aur



**Symbol Key:** Crosses = Negative observation, Triangle = Brighter than, Otherwise: Circle = Visual, Diamond = CCD/CMOS/PEP, Square = Photographic

**Contributors:** S W Albrighton, C J Evans, G Fleming, T L Heywood, R K Hunt, W Parkes, J Toone, C Watkins

Johnson V magnitude estimates submitted to the AAVSO are plotted below. Despite the poor coverage, analysis reveals a main period of 149d, with secondary periods of 364d and 1311d.

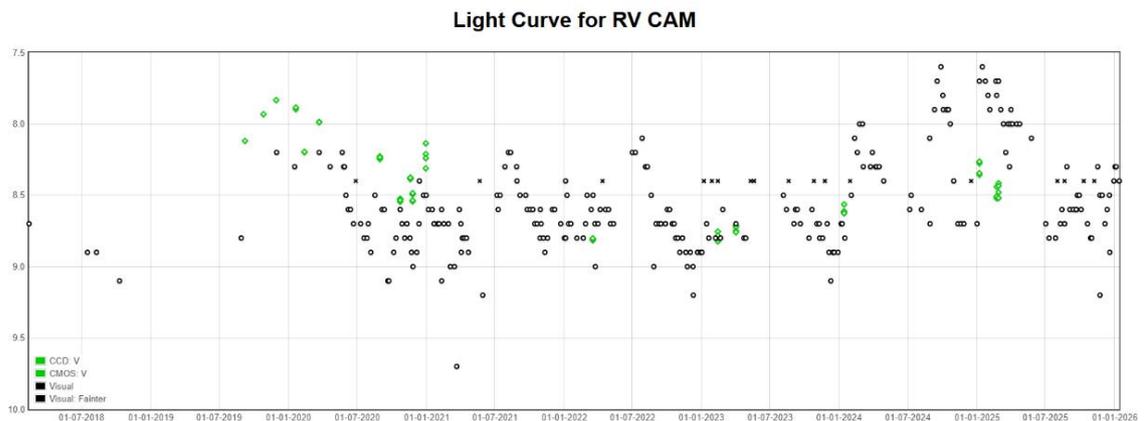


Continued observations are needed to confirm, deny and refine all of the results. The star would be an ideal addition for those using larger 70/80mm binoculars or smaller, 80mm-130mm telescope at low power. Likewise consistent CCD observations would be highly beneficial.

### RV Cam

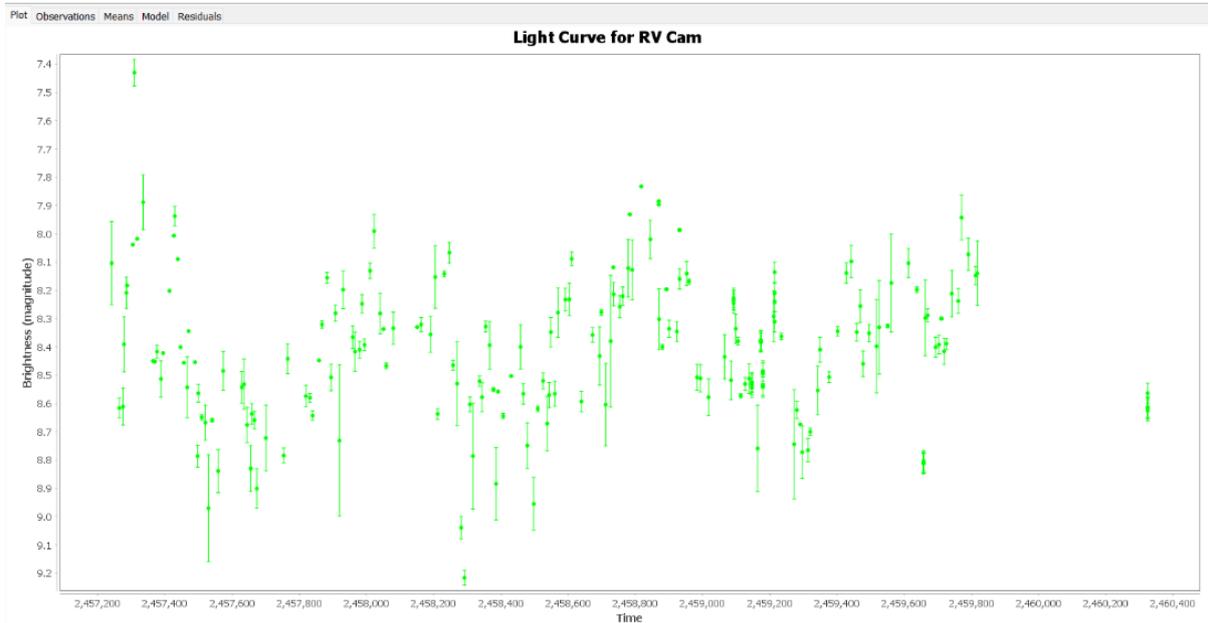
RV Cam was discovered by Williamina Fleming in 1907. It is listed in VSX as a SRb type variable, Spec M4II-III-M6, with a range of 9.3-10.6p and period 101d. The star lies near to the field of a number programme variables, U Cam, UV Cam, ZZ Cam and RY Cam, and is therefore easily added to the observers list.

A plot of BAAVSS observations since 2018, show that the star varies between 7.6 and 9.2. Analysis shows no indication of the 101d period, the peak results being for long periods of 1,900d and 863d. Specifically looking between 90d and 365d, gives peaks at 190d and 315d.



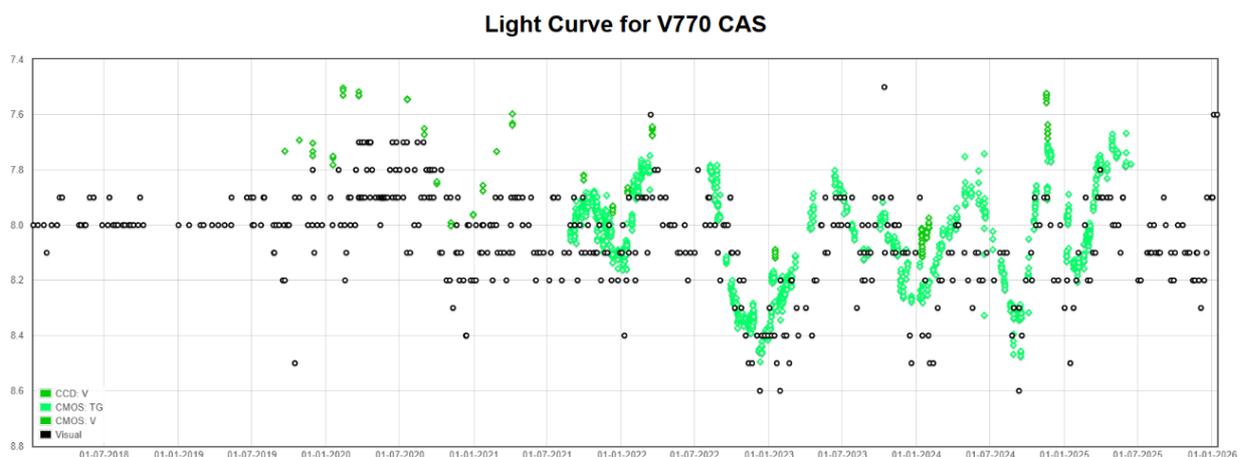
**Symbol Key.** Crosses = Negative observation, Triangle = Brighter than, Otherwise: Circle = Visual, Diamond = CCD/CMOS/PEP, Square = Photographic  
**Contributors:** S W Albrighton, G Fleming, J Toone

A plot of Johnson V estimates submitted to the AAVSO (see below), again fails to confirm any peak near 101d. The most obvious peak corresponds to a period of 819d. This can readily be seen by visual examination of the light curve below. As with TW Aur consistent observations both CCD and visual are needed, to examine this star over a longer period, to identify any shorter periods.



## V770 Cas

The VSX lists V770 Cas as a Lc variable, Spec M2lab, with a range of 7.61 – 8.47. The star lies in a beautiful star field, between  $\delta$  and  $\epsilon$  Cas, and close to two star clusters, NGC 663 and NGC 659. Observations submitted to the BAAVSS since 2018, (see plot below) indicate that the star displays significant variation between 7.6 – 8.6. CCD observations confirm the range and show cyclical variation. Analysing the observations however does not yield any obvious periods. The results give a scattering of periods, 607d, 1975d and 359d being the peak results.



Symbol Key: Crosses = Negative observation, Triangle = Brighter than, Otherwise: Circle = Visual, Diamond = CCD/CMOS/PEP, Square = Photographic

Contributors: S W Albrighton, G Fleming, T L Heywood, J Toone, C Watkins

Observations reported to the AAVSO are scattered with no consistent runs by single observers. As such, analysis revealed no meaningful results. At this stage the listed type of Lc seems appropriate.

### **Conclusion**

The three pulsating variables, TW Aur, RV Cam and V770 Cas, all show significant variation of at least one magnitude. As such they are suitable for both CCD and visual observers.

### **References**

- 1: AAVSO Variable Star Index [VSX](#)
- 2: General Catalogue of Variable Stars [GCVS](#)
- 3: AAVSO, [VStar program](#)

# High resolution Spectral measurements of S UMa

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***This article shows how high resolution spectroscopy may be used to obtain data on the dynamics of a Mira variable. In particular, for S UMa, it demonstrates the extraction of radial velocities from Doppler shifts, and the variability of complex features at the H alpha absorption line.***

## Introduction

S UMa is an example of a long period pulsating star of the Mira class. As such it shows radial pulsations which may potentially be studied using radial velocity measurements [1]. However such an interpretation has to proceed with caution as other interpretations, such as orbital components in binary systems [2], have been suggested. In addition Mira stars may show complex H alpha line profiles [3].

Studying all these phenomena requires spectroscopy that can resolve Doppler shifts down to a few km/s and split line features within 0.5 Angstrom. This is an interesting challenge for amateur observing, which is compounded by the fact that, as resolution increases, the limiting magnitude decreases. S UMa is a suitable Mira target as is a relatively bright star with magnitudes less than 11 for much of its period.

## Methods

High resolution spectra were taken of S UMa from March 2022 to April 2025 (with the bulk from July 2024 onwards). The spectrograph was a Shelyak LhiresIII with 2400l/mm grating mounted on a Celestron C11.

Data were reduced in Python. Subsequently, putative pulsation radial velocities were extracted from Doppler shifts using cross correlation between spectra. The conventional way of doing this is to use one spectrum as a 'template' against which the others are compared. However, it is possible to reduce the uncertainty in the outcome by using pairwise comparisons within a spectrum set [4] and this was the approach adopted here. The resulting values were heliocentrically corrected and mean subtracted.

In addition to pulsation phenomena, S UMa also shows interesting features in its H alpha emission line, as shown in the typical spectrum in Figure 1.

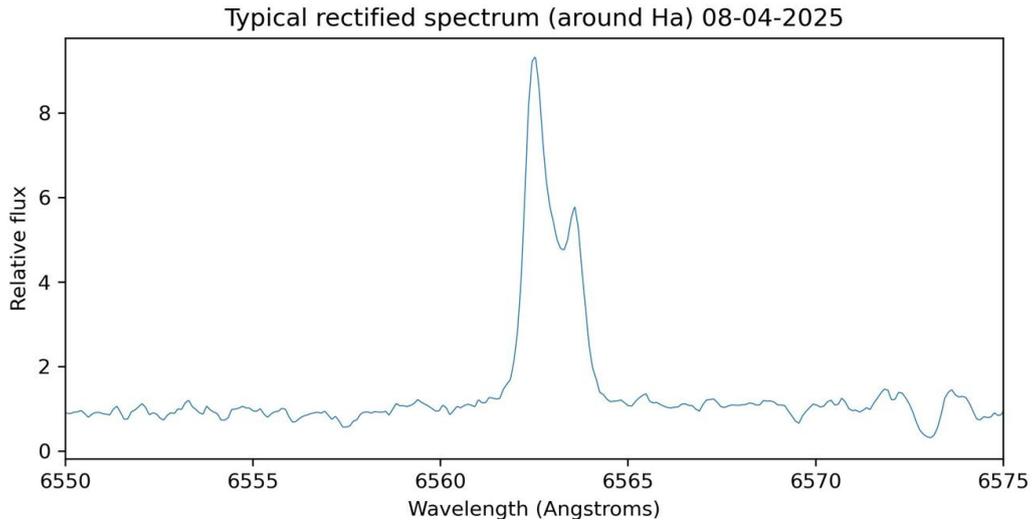


Figure 1.

In general, as shown in the figure, there were two peaks observed (although, in two instances, a third central peak could be detected). The peak values (relative flux values) were measured by first removing the spectrum continuum (rectification) and normalising to unity.

### Results: radial velocities

Figure 2 shows a time series of our radial velocity ( $V_r$ ) measurements, together with photometric V-band magnitudes ( $V_{mag}$ ). To ensure a good data density, the visual observations were used.

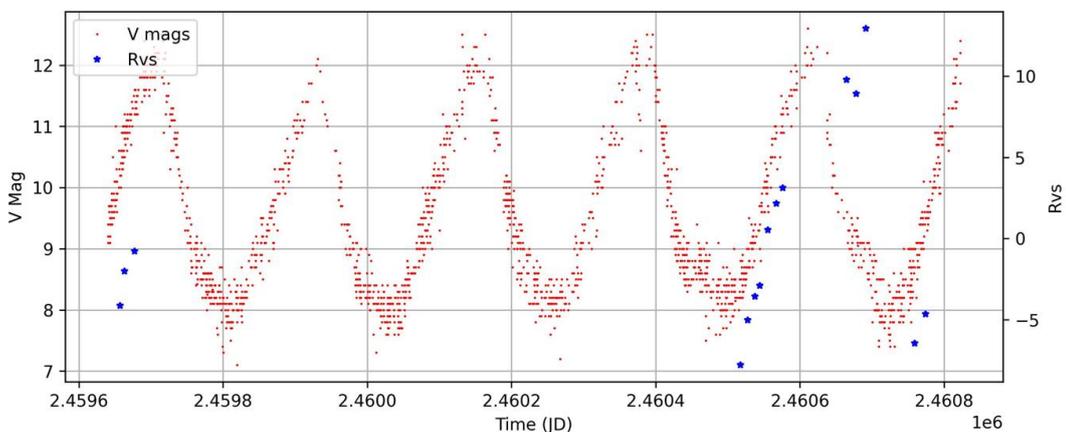


Figure 2.

There would appear to be some periodic patterning in  $V_r$  and some simple phase correlation with  $V_{mag}$ . Thus there is evidence of a monotonic rise over a half a period around  $T=2460600$ , and some indication this is approaching a minimum around 2460800. This whole period is of the same order of magnitude as its  $V_{mag}$  counterpart but shifted to the right. The three data points near  $T=2459600$  are consistent with this behaviour.

Periodicity analysis of the comparatively sparse (and temporally skewed) data set of  $V_r$  measurements will necessarily yield aliasing and similar ambiguities. However, the ANOVA method

performs well with sparse data [5] and is readily available in the periodic data analysis package Peranso [6]. Here, it gives the strongest peak at around 293 days (see Figure 3).

The second highest peak occurs at 438 days. There are also strong peaks very close to these values using the more usual Generalised Lomb-Scargle (GLS) method, although their relative height is reversed (i.e. 438 is slightly higher)

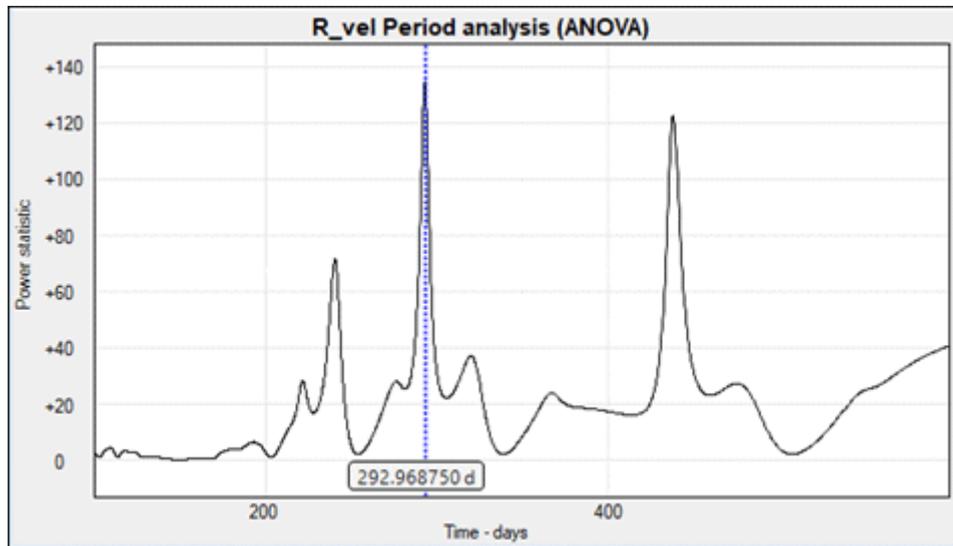


Figure 3.

Using the period of 293 days gives a phase plot shown in figure 4 (note the velocity axis is inverted). Using a period of 438 days, makes little difference to the patterning here.

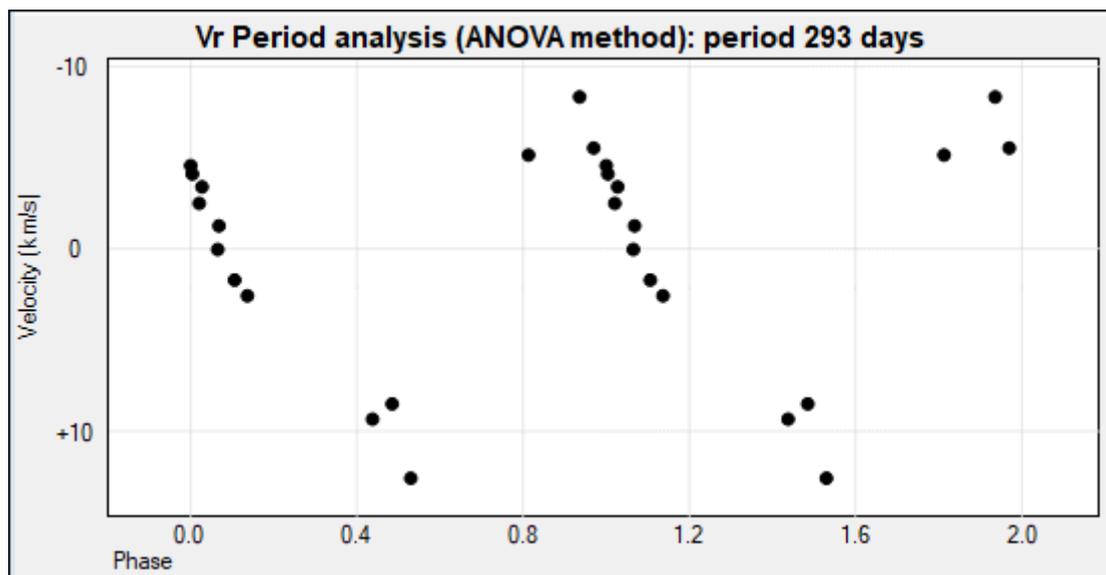


Figure 4.

## Results: Peaks around H alpha

The peaks in the features around H alpha show a strong periodic strength at 190 days (ANOVA and GLS). With this period we obtain the phase plot in Figure 5. The dashed line is a fit to the mean values highlighting the periodic shape which is less well pronounced than that for radial velocities.

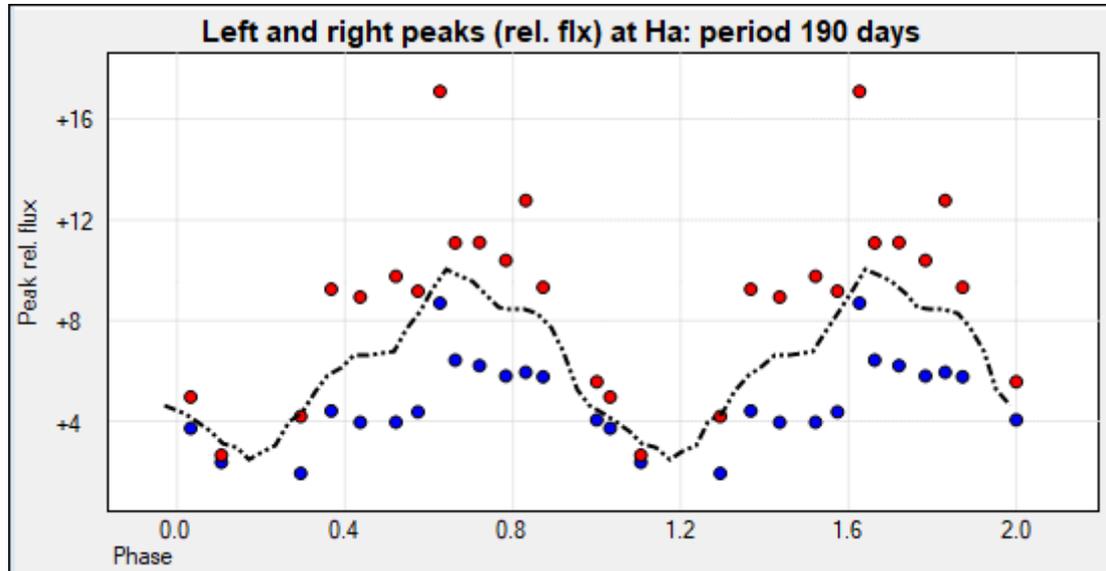


Figure 5: Peak values in H alpha profile against phase with period 190 days. Red and blue symbols are left and right peaks respectively.

## Discussion

Using amateur equipment it is possible to obtain radial velocity data for a Mira-type star that may have origins in a pulsation phenomenon. It is impossible to obtain definitive measurements of periodicity with sparse data sets such that shown here, and clearly any interpretation would benefit from more observations. In particular, period aliasing could be resolved by observation over much longer time scales. However, professional observation has also been prone to ambiguity, with a period of 592 days reported by Udry et al. [2] and 576 days by Famaey et al. [7]. Further Famaey et al. note that 2 of their 17 measurements differ markedly from the period they report.

The observations of multiple peaks is also consistent with published data such as that by Woodworth [3]. The latter study attempted to model the H alpha feature with three Gaussians, even though three distinct peaks were not clear. I also attempted such an exercise but, in our hands, the fitting did not appear robust and so I defaulted to the simple ('peaks') method of reporting.

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# CV & E News

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**Details of the 2026 outburst of the UGWZ star HV Vir, minor brightening of the symbiotic star AX Per, the fifth anniversary of V1405 Cas and the current low state of 3C 273.**

## HV Vir

Discovered by H Schneller in outburst on February 11, 1929 on two Harvard photographic plates and catalogued as NSV 6201 [1] and later identified as a classical nova by H. Duerbeck in 1984 from the outburst amplitude (~9 magnitudes), HV Vir was again seen in outburst in 1992 by Patrick Schmeer, who recorded it at magnitude 12.0 visual on April 20 of that year. The AAVSO IDB includes positive observations from Albert Jones 13 days prior to Schmeer at magnitude 14.4 visual (noted as archival). The 1992 outburst was extremely well monitored photometrically following Schmeer's alert, and the general appearance of the light curve in conjunction with photometric detection of superhumps and their development during the outburst, along with the very long outburst interval, led to HV Vir being classed as type UGWZ. The observations by Jones made 13d previous to Schmeer are unusual as they imply a slow rise to maximum, atypical in UGWZ stars.

Since the 1992 outburst there have now been a further four confirmed outbursts (Figure 1) – 2002 (missed by BAAVSS observers), 2008, 2016 and 2026, with one unconfirmed visual observation at magnitude 14.1 in April 1996. I conducted a simple Minor Planet check using the IAU MPCChecker [2], just to see if there were any close approaches of mag 14 asteroids in both 1992 and 1996, with a negative result to both. Interestingly, at no time during these historical outbursts has HV Vir displayed any rebrightenings we so often see at the end of a UGWZ outburst event.

The 2026 outburst was detected on a SLOOH Chile 2 image on Jan 05.291UT at magnitude 11.96V, the first detected in a decade. Coverage by VSS observers was low, with just two observers contributing data – I. Sharp and G. Poyner. Early superhumps of 0.1 amplitude was reported by Yusuke Tambo on vsnet-outburst 31610 (Jan 8), from observations made by Kubotera, Itoh, Hamsch, Sharp, Jani and Starr, developing into stage-B ordinary superhumps by Jan 15. HV Vir entered a rapid decline from the plateau stage on Jan 27, fading to 17.5CV by Feb 04, some 30 days after detection (Figure 2)

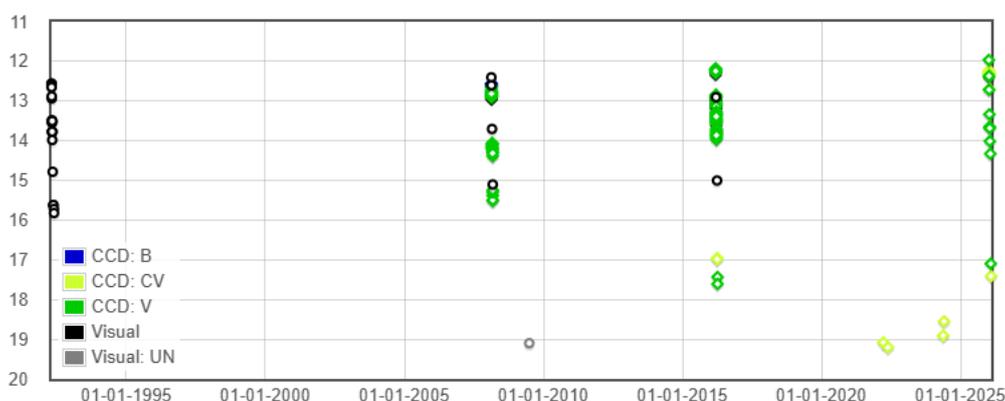


Figure 1. Outbursts of HV Vir covered by the BAAVSS. 1992-2026. (BAAVSS Database)

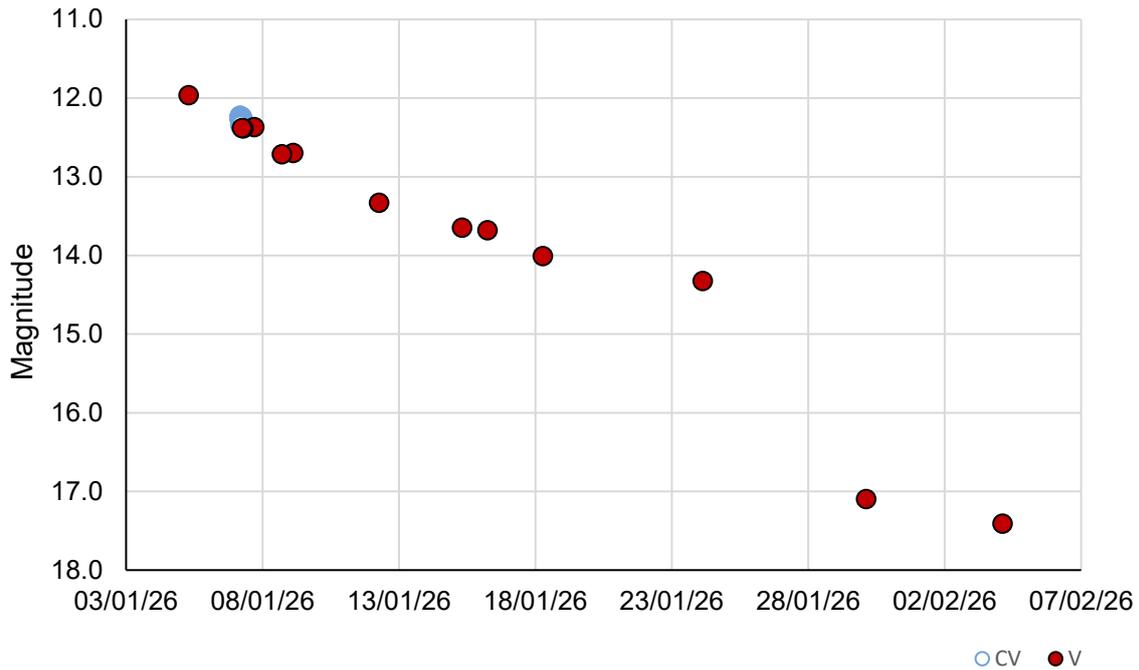


Figure 2. The 2026 outburst of HV Vir. I. Sharp & G. Poyner (*BAAVSS Database*)

### AX Per

A brightening of the well observed symbiotic star AX Per was announced on ATel [#17630](#) on January 26, 2026. Quoting ATel, “The V magnitude rose from 11.42 (JD+1053.5) to 10.92 (JD+1058.4) while B-V declined from 1.22 to 0.95”. Poor weather during the end of January and the first half of February has meant just two observations of AX Per have been reported to the VSS DB between Jan 28 and Feb 11. An inspection of the AAVSO IDB reveals that this minor brightening peaked at magnitude 10.8V on Jan 18, before slowly fading to 11.1mv by Feb 14.

AX Per has been monitored by BAAVSS observers since 1988 (Figure 3), and the light curve shows a number of outbursts brighter than magnitude 10.5, including the two major events of 1988 and 1989. AX Per also displays eclipses every 680.83d (the  $P_{orb}$ ). The last eclipse unfortunately occurred on June 25 2024, when the field is extremely difficult to observe. The next one is due on May 7, 2026 – again unfavourably placed for observation. The eclipses are just under one magnitude in depth and are superimposed in the intrinsic variations displayed by AX Per, so do not generally stand out in a visual inspection of the light curve.

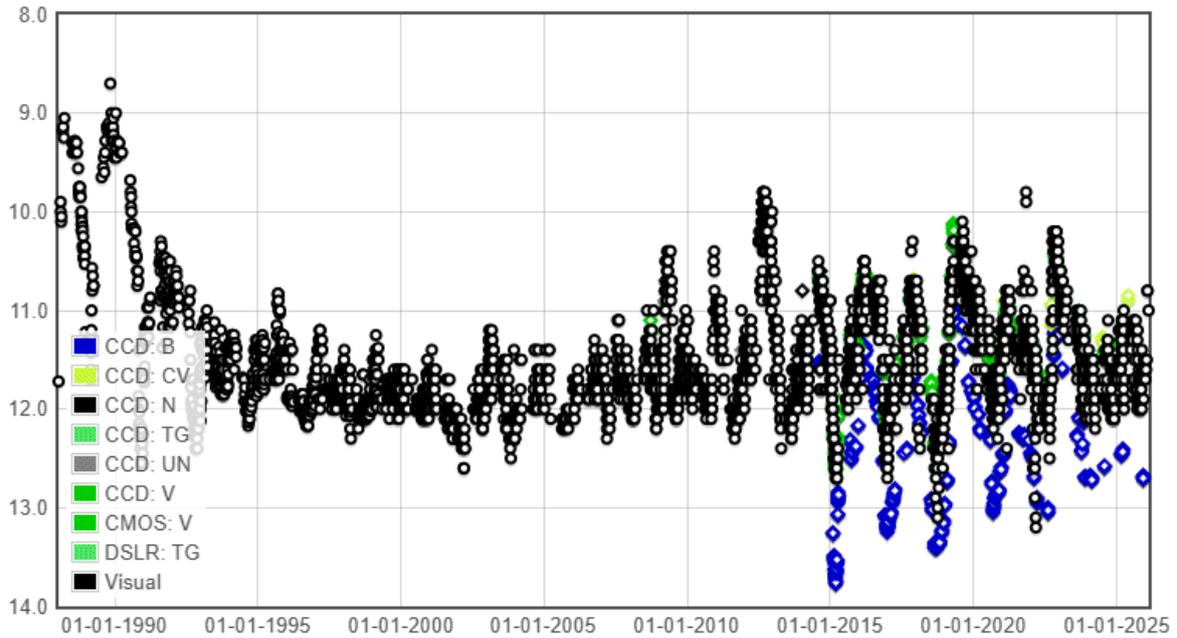


Figure 3. AX Per, 1988-2026. *BAAVSS database*

### 3C 273

This historically important quasar (the first to be identified and which remains the brightest of its type), is currently at its faintest brightness level since its discovery in the 1960's. Usually found varying between 12.8-13.2V, a fade began at the end of 2022 which reached magnitude 13.3 by July 2023. After a relatively steady period during 2023-24 around magnitude 13.3V, 3C 273 faded again during February 2025 to its present level of 13.5CV in February 2026 (Figure 4).

Found in the constellation of Virgo, 3C 273 can be observed from late winter to early Summer, with obvious quiet periods in each month due to the presence of the Moon. Observers are asked to observe 3C 273 during the current apparition and report their observations as promptly as possible to the database.

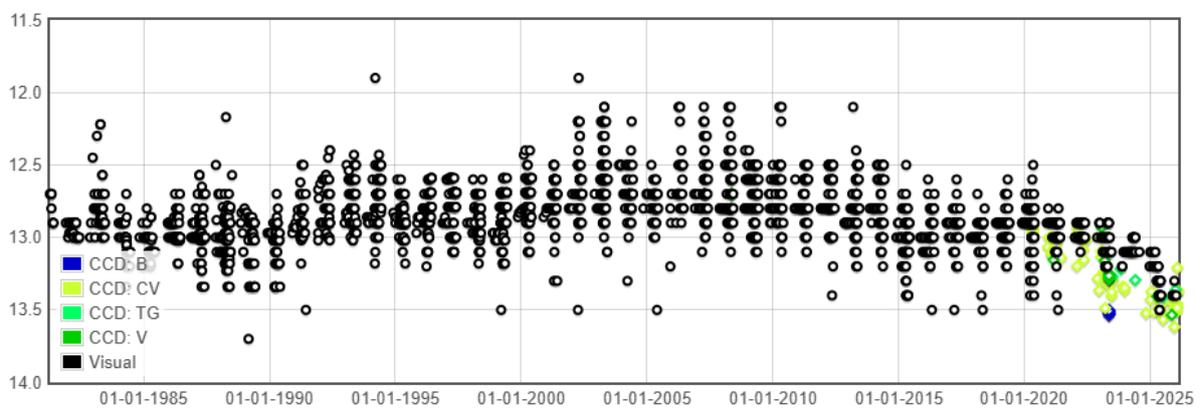


Figure 4. 3C 273 1981-2026. *BAAVSS database*

## V1405 Cas

Amazingly, March sees the fifth anniversary of the discovery of V1405 Cas (Nova Cas 2021) – a very rare naked eye Nova (albeit briefly) visible in the Northern hemisphere (the first naked eye nova for 8 years), and a Nova which is still visible with small telescopes at around a mean magnitude 13.0V (Figure 5).

Discovered by Japanese amateur Yuji Nakamura on March 18.423 at magnitude 9.3CV, the nova peaked at magnitude 5.5V in early May and experienced several rebrightenings before slowly fading to magnitude 13.0mv in October 2024, where it has remained, displaying fluctuations between magnitudes 12.8-13.5 visual. Observations of the spectrum at maximum light revealed V1405 Cas to be an Fe II type nova, where the origin of the outburst is the secondary star though a large circumbinary envelop, rather than the white dwarf itself [3]

Reported observations have sadly diminished since discovery. In 2021, 4,349 observations (of all types) are listed in the database. In 2025, a mere 255 observations were reported. This trend is typical with all novae, but surprising in V1405 Cas, as the quiescent magnitude is 15.6V and we have a way to go before the nova returns to its pre-eruption levels. Continued observations are to be encouraged.

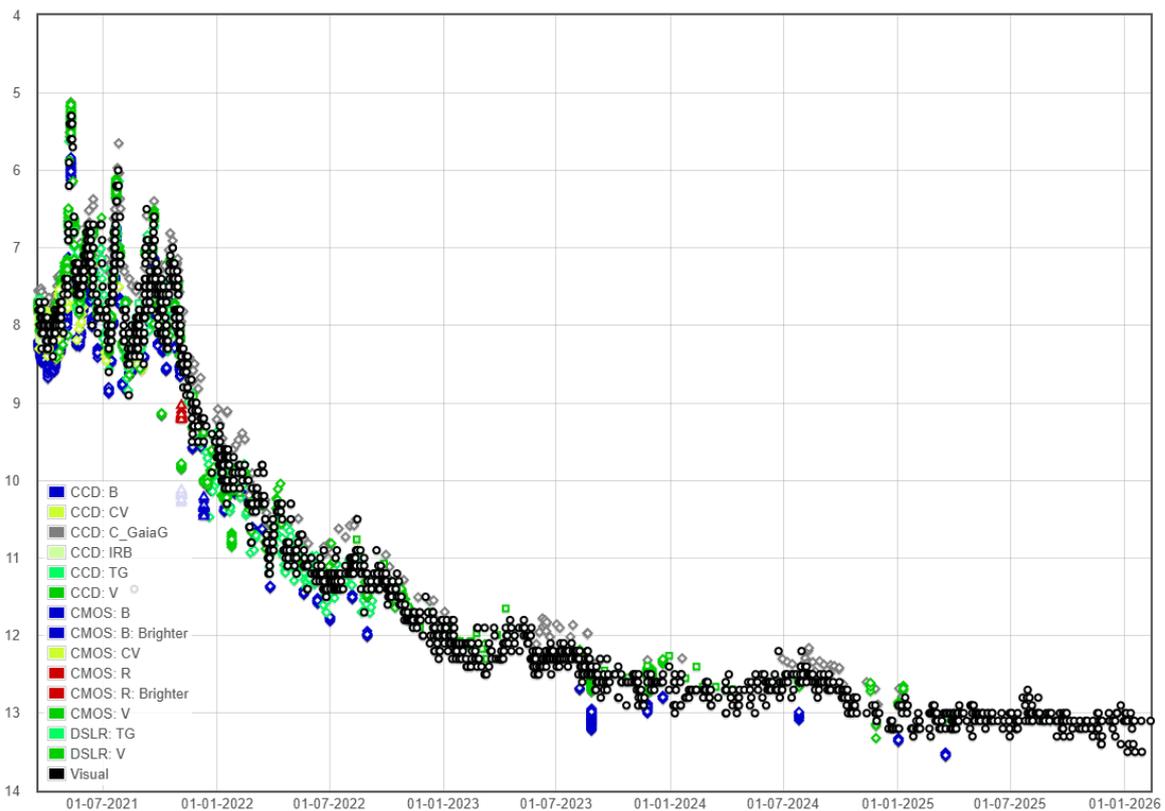


Figure 5. V1405 Cas from discovery to February 2026. *BAAVSS Database*

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- 2: IAU Minor Planet Center [MPCChecker](#)
- 3: [Origin of the 'He/N' and 'Fe II' Spectral Classes of Novae](#). Robert Williams. AJ 144

# AB Aurigae – The Deep Fades of 2025

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***A summary account of the remarkable October & November 2025 fades of AB Aur that in historical terms are the deepest on record.***

AB Aur is the Northern hemisphere's brightest Herbig Ae pre-main sequence star, normally fairly steady at magnitude 7 but with occasional dust obscuration events causing fades to magnitude 8. [1] After many years of exhibiting limited variation & very brief fades, AB Aur became more active during the 2024/2025 apparition, [2] and the 2025/2026 apparition currently in progress, has shown unprecedented, elevated activity.

AB Aur was originally confirmed to be a variable star through variations recorded on photographic plates taken at Harvard during the years 1899-1921 when it was quite active with several fades to magnitude 8 or below. [3] The deepest fades recorded within that timescale occurred in 1906 & 1916 when minimum of 8.4p were measured. The same magnitude was attained on the first fade to be detected by visual means many years later in 1975. [4]

The nominal B-V of AB Aur is +0.2 whilst the nearest comparison stars E, F & L have B-V values ranging between +0.11 & +0.36. Therefore, the colour of AB Aur is essentially the same as the nearest comparison stars that are used during fade events, resulting in a broad alignment between historical photographic values and modern day visual and V photometry.

Figure 1 plots the visual observations of AB Aur in the BAA VSS database for the period August to December 2025. The overall variation resembles an RV Tauri light curve but with imposed short-term fluctuations. The fade to 8.2mv in the month of August has been described in a previous report. [5] An even deeper fade followed reaching 8.5mv at the time of the VSS meeting in Northampton on the 25th of October. This fade was imaged by Colin Henshaw (reproduced in Figure 2) and Colin measured a value of 8.56V. Note that this fade was marginally deeper than all previously reported fades and briefly represented a record, which is until the following month.

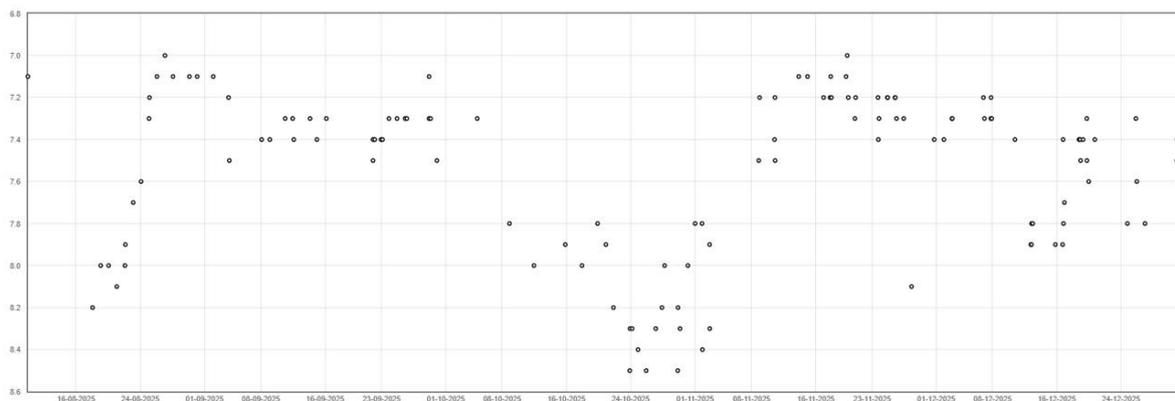


Figure 1: Light curve of AB Aur from August to December 2025 drawn from BAA VSS visual observations. Variations occurred on a nightly basis with three significant fades below magnitude 8 recorded.

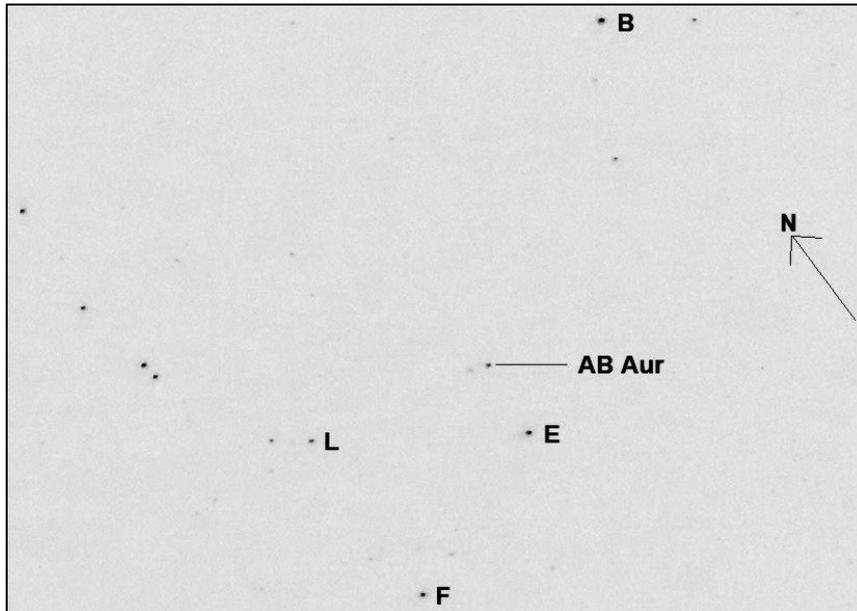


Figure 2: Image of AB Aur on 26 October 2025 at 00:32 GMT taken by Colin Henshaw from Bowden, near Altrincham. This captures AB Aur at a record faint level only for the record to be exceeded just one month later. Comparison stars B (6.7), E (7.6), F (8.0) & L (8.8) from BAA VSS chart 301.01 are labelled.

The light curve in Figure 1 includes an isolated observation by Shaun Albrighton on the 27<sup>th</sup> November which is approximately 0.8 magnitude fainter than the other observations made around the same time. This observation is not erroneous because there was a very deep fade that lasted only a few days in late November. To obtain maximum detail on this brief event I have listed within Table 1 photometry drawn from both the AAVSO and BAA VSS databases. Thanks to the work of James Foster, it is established that AB Aur dropped to 8.9V early on the 29<sup>th</sup> November (it may have gone fainter, but there is no available data on the 28<sup>th</sup> November). This represents the deepest recorded fade of AB Aur to date.

Date 2025	Mag	Observer	Location
Nov 26.39	7.3V	James Foster	USA
Nov 26.97	7.3mv	John Toone	Spain
Nov 27.94	8.1mv	Shaun Albrighton	UK
Nov 29.33	8.9V	James Foster	USA
Nov 29.75	8.4mv	Andras Uhrin	Hungary
Nov 30.35	7.7V	Ken Cunningham	Canada
Nov 30.40	7.7V	James Foster	USA
Nov 30.75	7.4mv	John Toone	UK
Dec 01.39	7.4V	James Foster	USA

Table 1: Photometric observations of AB Aur from the AAVSO & BAA VSS databases during the period November 26.3 to December 1.4 capturing the record deep fade. Note the geographical spread of observations across five countries in Europe & North America, an important collective effort given the brief nature of this event.

It is worth noting that the record deep fade of AB Aur on 29<sup>th</sup> November 2025 occurred exactly fifty years after the first visually detected fade on 29<sup>th</sup> November 1975. [6] The second visually detected fade on 1<sup>st</sup> December 1997 was also on a similar date in the calendar year. Each of these three fades whose calendar dates overlapped 22 and 28 years apart, were very rapid and accomplished within three days.

AB Aur is continuing to exhibit significant variability in early 2026. On the 19<sup>th</sup> January the star faded to 8.3mv and eight days later it recovered to 7.1mv. In summary, the resurgence of activity in 2024 has preceded variations in 2025 exceeding in depth those recorded back in 1906, 1916 & 1975. So clearly, we are currently in the midst of an extraordinary active phase in the photometric history of AB Aur.

#### **References:**

1. 2019 VSS Circular, [180, 10](#)
2. 2025 VSS Circular, [203, 11](#)
3. 1924 BHarO, 798, 7
4. 2024 VSS Circular, [202, 13](#)
5. 2025 VSS Circular, [206, 30](#)
6. 1998 VSS Circular, [95, 13](#)

# The intriguing absence of superoutbursts for V1159 Ori. A shift to a new state?

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***Since 2010 the interval between superoutbursts has been increasing gradually from about 45 to 70 days. However, in recent observing seasons very long intervals of 130 and 126 days have occurred. This suggests that V1159 Ori may be evolving rapidly.***

## Introduction

Dwarf novae (DNe) are binary systems comprising a white dwarf with a companion star from which matter is being drawn into an accretion disc. This flow of matter leads to temperature oscillations in the accretion disc which in turn produce a series of brightening events known as normal outbursts. When the disc radius grows to a certain size, the disc becomes unstable and a long duration superoutburst, usually brighter than normal outbursts, returns the disc to its initial state. The sequence of normal outbursts followed by a superoutburst then repeats. The time between superoutbursts is known as the super-cycle period  $P(sc)$ .

The Variable Star Index (VSX) [1] gives the following definition for UGER stars:

*ER Ursae Majoris-type subclass of UGSU dwarf novae. These stars typically spend a third of their time in super-outburst with a super-cycle of 20-90 days. Outside of super-outburst they typically pack in a rapid succession of normal outbursts.*

UGER stars therefore offer the opportunity to observe many normal outbursts and several superoutbursts per year or observing season. VSSC 187, 188, 190 and 193 have included reports on IX Dra, ER Uma, RZ LMi and V1159 respectively. This note follows the intriguing behaviour of V1159 Ori since 2022.

V1159 Ori has a brightness range of 12.4 to 15.2 and coordinates of RA 5 28 59.52 and Dec -3 33 52.9 according to VSX [1]. The observing season starts in July and runs until the end of May based upon AAVSO database entries.

## V1159 Ori literature review

As part of a larger study of UGER type stars, M. Otulakowska-Hypka and A. Olech [2] averaged individual V1159 Ori supercycle periods, extracted from AAVSSO and other records, into five data points to produce the graph (reproduced from their paper) in Figure 1 below.

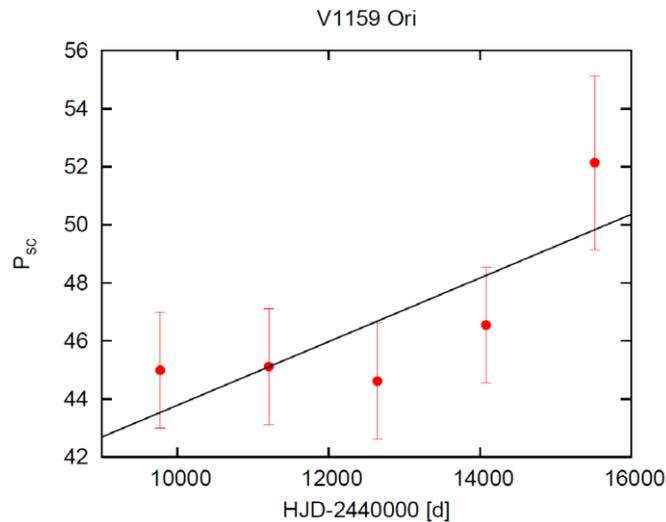


Figure 1. The averaged super-cycle period for V1159 Ori from M.Otulakowska-Hypka and A. Olech [2]

Kato [3] analysed the observations made by the VSNET collaboration, including contributions from BAA VSS observers, between 1995 September and 2001 March. The quality and number of observations enabled an average supercycle period of 46.8 days to be determined, although the period did vary around this mean value.

### Background from VSSC 193.

An analysis was provided in [VSSC 193](#) and is presented again in Figure 2. The early epoch from JD 2450000 to JD 2456000 had a super-cycle period broadly centred on 45 days with some notable exceptions. Since then, the super-cycle period has gradually, if irregularly, increased. Since JD 2458000 all periods between superoutbursts have been longer than 45 days with an increasing trend.

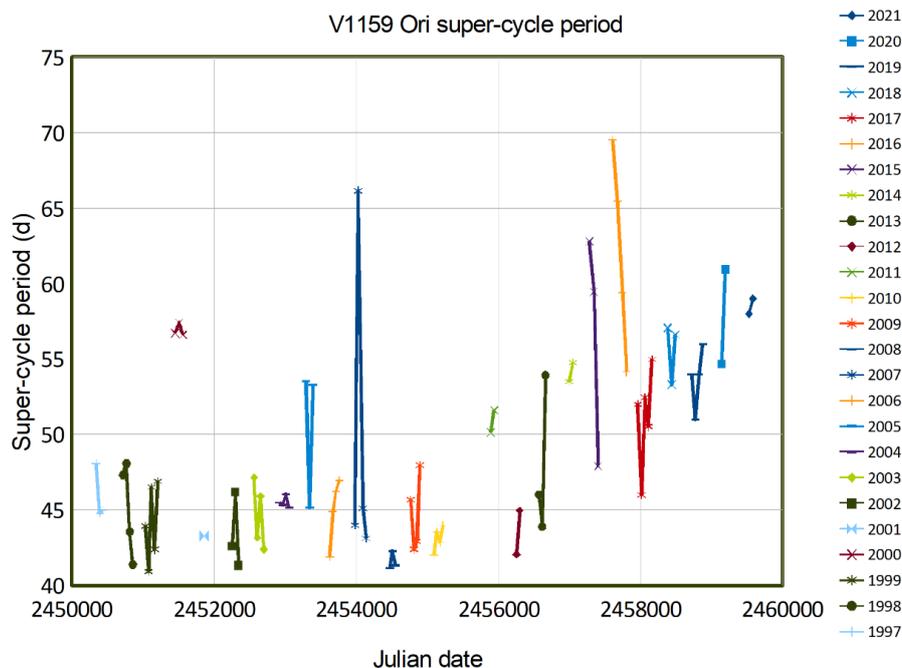


Figure 2. The super-cycle period/intervals for V1159 Ori to JD 2460000. Each observing season is identified by colour and symbol

## Updated analysis and indications of long intervals between superoutbursts

The updated analysis includes results from the observing seasons 2022 to 2026 as shown in Figure 3. The observing season 2025/2026 continues and so it is possible that another superoutburst will occur. In both the last and the current observing seasons only two superoutbursts have been recorded in each season. The intervals between these pairs are 130 days and 126 days. These two intervals are, by a large margin, the longest in the 25-year observing record indicating that a significant change may have happened.

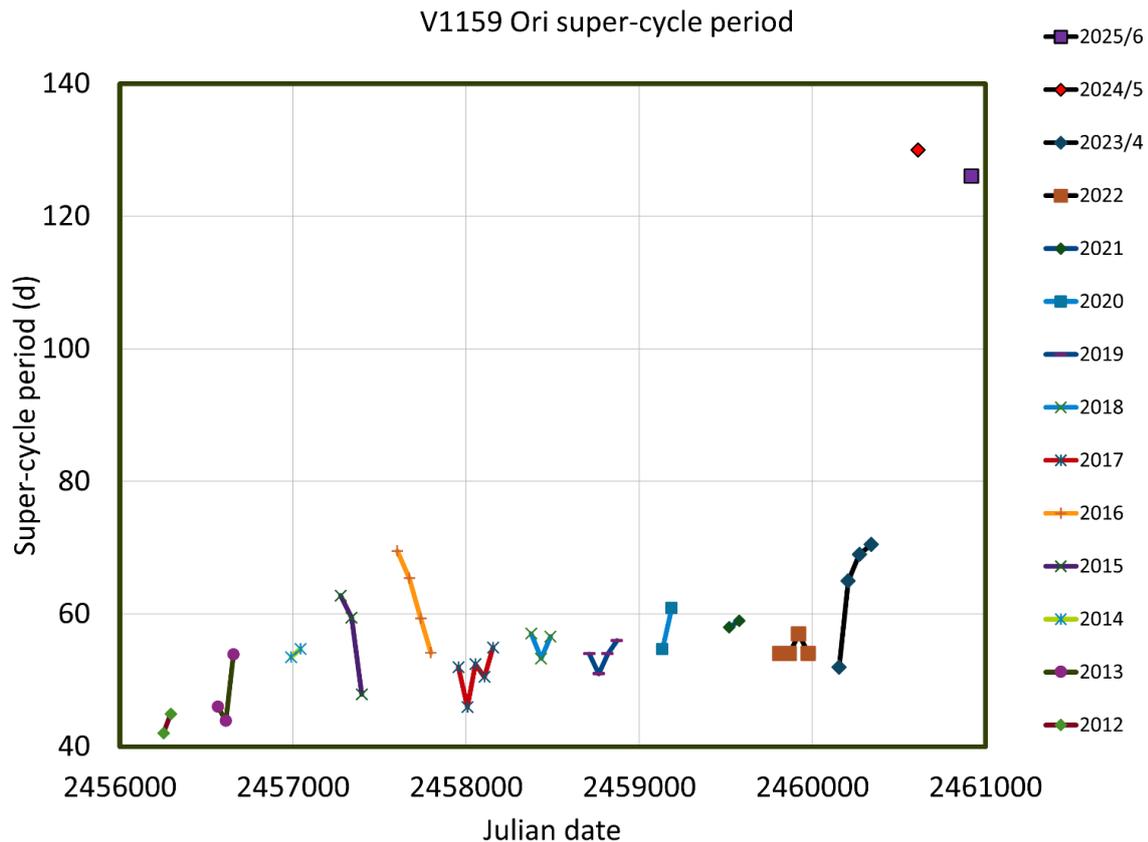


Figure 3 The super-cycle period for V1159 Ori from 2012 to the 2026 observing seasons. Each observing season is identified by colour and symbol

## Discussion

Solar conjunction is a difficulty that V1159 Ori presents as it is likely that some superoutbursts will not be observed. If period between superoutbursts is consistently short, around 45 days, the absence of observations is not significant. However, if intervals extend to around 100 days there is then a good chance that a superoutburst has been missed. Certainly, the 200 day interval between the superoutburst at JD 2460400 and the superoutburst around JD 2460610 seems unlikely to be real.

For V1159 Ori normal outbursts tend to grow in magnitude during the period between superoutbursts. This behaviour is seen in the light curve and suggests that a superoutburst did occur around JD 2460500. If this hypothetical superoutburst had been recorded, two additional data points with values of 90-110 days would be in Figure 3.

As the recent long intervals are approximately twice as long as previous intervals another possibility is that superoutbursts have been missed during the observing seasons. However, this author cannot find suitable gaps for such missing superoutbursts.

Kato [3] suggests that, in general, longer superoutburst periods correspond to low flow rates from the donor star to the white dwarf. Normal outbursts have continued throughout the last and the current observing season. Indeed, there is no obvious change in any characteristic of the normal outbursts. Whilst normal outbursts have continued, it seems that the necessary condition for a normal outburst to transition to a superoutburst is not being met as often.

Should V1159 Ori now even be considered as one of the UGER subclass of UGSU stars? The VSX definition for UGER stars is, of course, arbitrary and it may be that the eye catching and interesting superoutbursts are not a defining feature. The '*rapid succession of normal outbursts*' may be the more useful characteristic. If so, V1159 Ori remains best classified as UGER.

### **Summary**

V1159 Ori seems to have shifted to long intervals between superoutbursts. Only further observations extending over years can determine if this is a temporary state or something more permanent. This is long-term monitoring suits the amateur community well and further observations are encouraged.

### **Acknowledgements**

I acknowledge with thanks all BAA-VSS and AAVSO members who contributed observations without which this note would not be possible. I hope they will continue their observations. I also thank the AAVSO for agreeing to observe V1159 Ori with their AAVSONet telescopes in New Mexico and Australia under Project Number 257.

### **References**

- 1: The International Variable Star Index (VSX) (aavso.org)
- 2: M. Otulakowska-Hypka and A. Olech, MNRAS 433, 1338–1343 (2013)
- 3: Kato, T. Publ. Astron. Soc. Japan 53, L17–L19, 2001 August 25

# SS Cygni: An analysis of quasi-periodic oscillations in the range of 0.25h to 8h

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***Presented here is an analysis of over 66,000 magnitude measurements, made by the author, of the cataclysmic variable SS Cygni in two photometric filters (Cousins R and Johnson V). This large number of measurements, along with their cadence, is sufficient to analyse the light curve for quasi-periodic oscillations (QPOs) ranging from a few minutes to a few hours with the most frequently found QPOs having periods of 30 minutes (48 cycles/day). These QPOs occur predominantly during quiescent phases rather than outbursts, representing a previously understudied aspect of SS Cygni's variability.***

## Introduction

In 1896 Louisa D. Wells, a computer at the Harvard College Observatory, discovered the variability of SS Cygni (SS Cyg) and since that time it has become, perhaps, the most well studied variable star system of all. On a personal note, I have been observing this star since 1974 when I made a few visual magnitude estimates alongside my friend and mentor at that time: Dr John Mason (currently the director of the BAA Meteor Section). More recently, CCD photometry has become my main activity and I have acquired over 66,000 brightness measurements of SS Cyg since June 2024 and it is on that set of data this study is based.

SS Cyg is a cataclysmic variable (CV) star meaning one that irregularly increases in brightness by a large factor from a quiescent state. CVs are binary star systems that consist of a white-dwarf primary and a mass-transferring secondary which, in the case of SS Cyg is a red-dwarf with a temperature of 4560K. The binary period is approximately 0.275d (6.6h) and the semi-major axis separation is just over  $1.8R_{\odot}$ . SS Cyg shows no eclipse due to the binary inclination of  $\approx 50^{\circ}$ . More system parameters of SS Cyg can be found in [Voloshina et al. \(2012\)](#).

Figure 1 shows the light curve of SS Cyg using the magnitude measurements made by the author using Cousins R and Johnson V filters from 2024 June to 2026 January. The choice of R and V was made long before a large analysis was envisaged otherwise a photometric B filter might also have been chosen. However, it has been possible to keep the cadence of exposures higher with just R and V. This plot clearly shows the familiar irregular outburst in brightness which occur in the time interval of 25 to 73 days. Notice the peaks appear to come in wide and narrow varieties and that the magnitude typically varies between  $V_{\text{mag}} = 12.0$  at the dimmest parts of the quiescent phase and brightens to around  $V_{\text{mag}} = 8.5$  during outburst. The sample of outbursts shown in Figure 1 is typical of the hundreds of outbursts that have been recorded for well over 100 years by members of the British Astronomical Association (BAA) and the American Association of Variable Star Observers (AAVSO), however there was a hiatus in the usual pattern of outbursts around 2021 described by Jeremy Shears here on the BAA's YouTube channel in a BAA Weekly Webinar entitled "[Is SS Cygni losing the plot?](#)"

The instrumental magnitudes plotted in Figure 1 were obtained by performing ensemble differential aperture photometry using the [AstroArt](#) software package controlled by [Python](#) utilities written by the author. The images were captured using the author's equipment based in the UK and Spain. The telescope in the UK is a 235mm Schmidt-Cassegrain (SCT) and the one in Spain was a 280mm SCT.

Both systems used a Starlight Xpress SX694 TRIUS PRO CCD camera and both operated at a focal ratio of  $f/7$ . However, the camera in Spain has recently been changed to a Moravian C3-26000 CMOS.

Notice in Figure 1 how the red and green points cluster together as vertical lines of varying height. This is because the dataset includes just over 300 nights of photometric measurements made up of many points per night. All exposures are 30 seconds and the average number of images per night is about 220 where the maximum number in any night was 1081. Because of this it is not possible to see any detailed structure in the light curve for any one night in Figure 1 due to the large time span on the x-axis covering about 600 days.

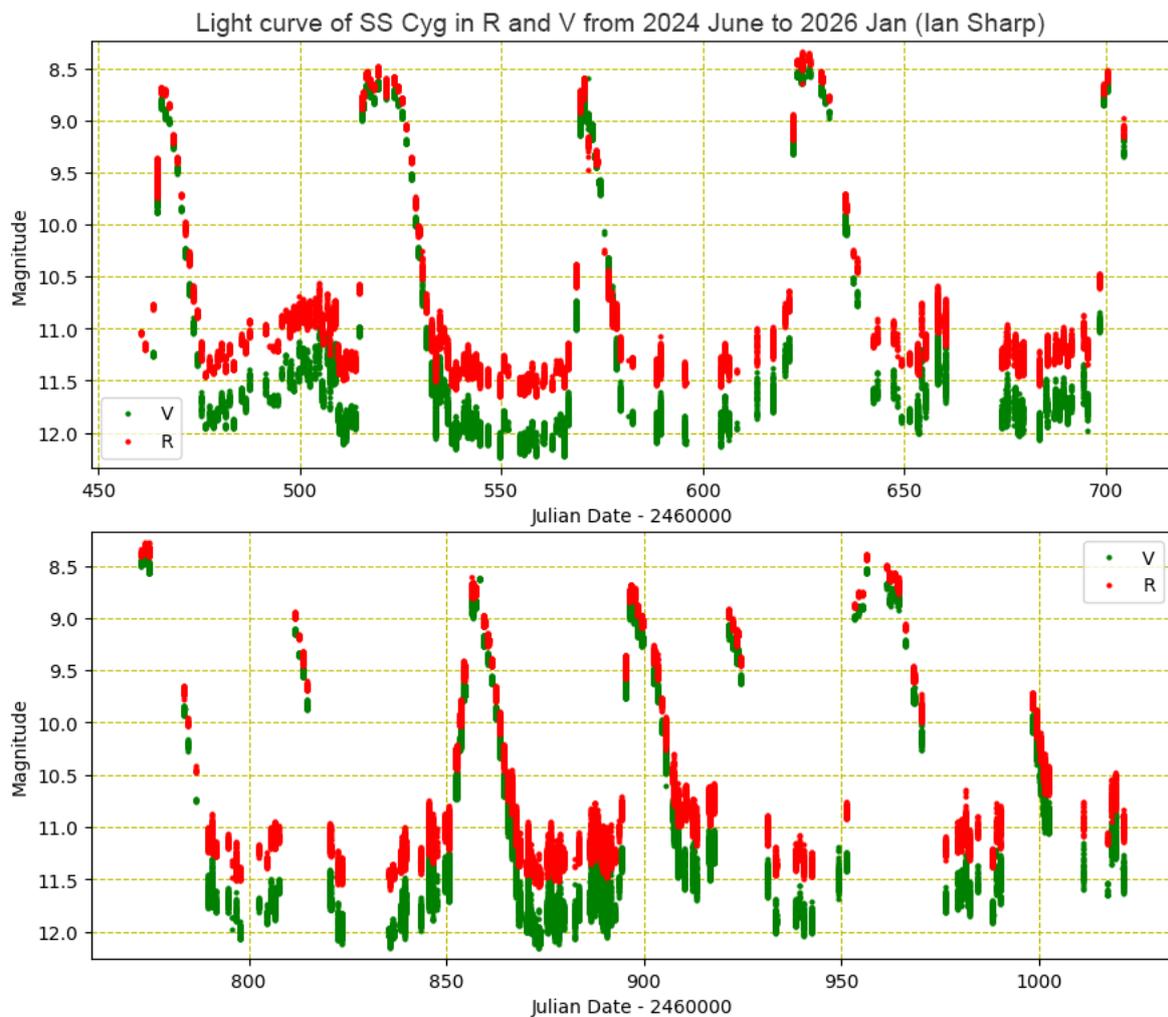


Figure 1. The light curve of SS Cygni using data from the author with R and V photometric filters from 2024 June to 2026 January. A total of 66,062 magnitude measurements are shown on the two charts in Figure 1 and the familiar outbursts are clearly shown. It can also be seen that the variability and differences in the V and R magnitudes are much greater in the quiescent phases.

To see more detailed structure and detect shorter-term variations in the light curve it is necessary to plot and analyse each night separately. The cadence of the exposures is approximately 45 seconds (including file download time) where the filter is swapped between R and V on every exposure so that the typical cadence between exposures of the same filter is around 90 seconds. Because of this it is not possible (due to the [Nyquist-Shannon sampling theorem](#)) to determine any periodic frequency components in the light curves with periods with of less than 180 seconds (3 minutes). Conversely the typical run length in any one night of around 2 to 4 hours restricts the lowest frequency component that can be extracted from the light curves.

The restrictions imposed by the minimum sampling frequency and the typical length of any nightly dataset described above determine the upper and lower frequencies of any periodic oscillations that can be analysed-out of the light curves and, in this study, the limits are set to 0.25 to 8 hours.

## Previous Studies

There are several studies of SS Cygni that specifically investigate periodic variations in brightness, particularly rapid oscillations and quasi-periodic oscillations seen during outbursts or at high time resolution. Below is a list of studies that include findings of oscillations in the light curve of SS Cyg.

1. [Robinson & Nather \(1979\)](#) – *Quasi-periodic luminosity variations in dwarf novae*.  
Includes SS Cyg and reports ~32 s quasi-periodic oscillations in its light curves.
2. [Horne, Gomer, et al. \(1980\)](#) – *Phase variability in the rapid optical oscillations of SS Cygni*.  
Includes high-speed optical photometry reporting ~8 s oscillations.
3. [Hildebrand, Spillar & Stiening \(1981\)](#) – *Observations of fast oscillations in SS Cygni*.  
Early detection of rapid photometric oscillations during outburst.
4. [Cordova et al. \(1984\)](#) – *Observations of quasi-coherent soft-X-ray oscillations in U Gem and SS Cyg*.  
Quasi-coherent X-ray oscillations in SS Cyg during decline from outburst.
5. [Mauche & Robinson \(2001\)](#) – *First simultaneous optical and EUV observations of the quasi-coherent oscillations of SS Cygni*.  
EUV and optical oscillations observed simultaneously; includes frequency changes (“frequency doubling”).
6. [Mauche \(1996\)](#) – *Quasi-coherent oscillations in the extreme ultraviolet flux of SS Cygni*.  
Detailed study of EUV oscillation periods changing throughout outburst.
7. [Mauche \(2003 review\)](#) – *Optical, UV, and EUV oscillations of SS Cygni in outburst*.  
Summarizes multiwavelength quasi-periodic phenomena and places SS Cyg’s oscillations in context with other compact binaries.

The studies listed above describe oscillations that are typically classified as dwarf nova oscillations (DNOs) or low-coherence quasi-periodic oscillations (QPOs), often with periods of ~7–40 s during outbursts. The studies above span optical, Extreme UV, and X-ray bands. DNOs are higher frequency (tens of seconds), more coherent oscillations linked to the white dwarf’s rapidly spinning equatorial belt during outburst, while QPOs are lower frequency (hundreds of seconds), broader oscillations likely caused by vertical waves or thickening in the inner accretion disk.

For citations that include SS Cygni’s quasi-periodic light curve behaviour during outburst in longer timescale studies or in photometric surveys, see [Voloshina et al. \(2012\)](#), which discusses QPOs from ground-based light curves indicating quasi-periodic signals near peak and decline.

It appears that there are no studies that cover the frequency range with periods between 0.25 and 8 hours as discussed in this study. Additionally, it is clear from Figures 2 and 3 that there is more variability in magnitude during the quiescent phases than the outbursts and this becomes more apparent when the individual nightly light-curves are examined. However, most other studies seem to ignore the quiescent phases.

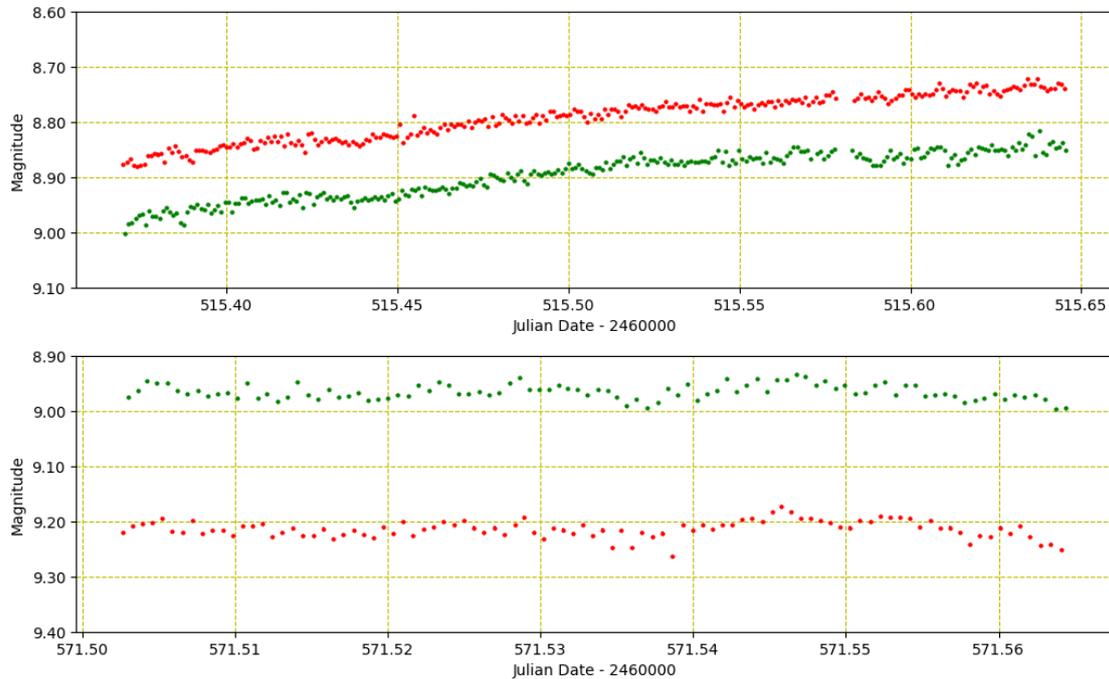


Figure 2. Two examples of nightly light curves in both R and V filters taken during outburst. Note the lack of variability compared to curves captured during the quiescent phases.

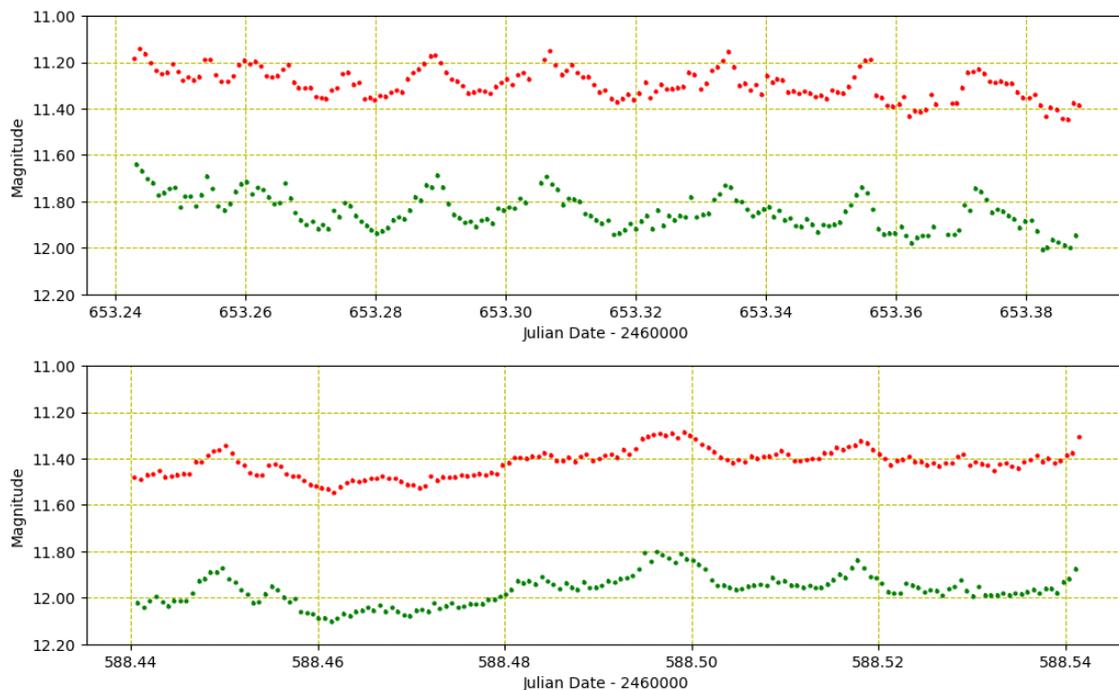


Figure 3. Two examples of nightly light curves in both R and V filters taken during quiescence. Note the variability in magnitude is much greater than the light curves captured during outburst.

## Data Analysis

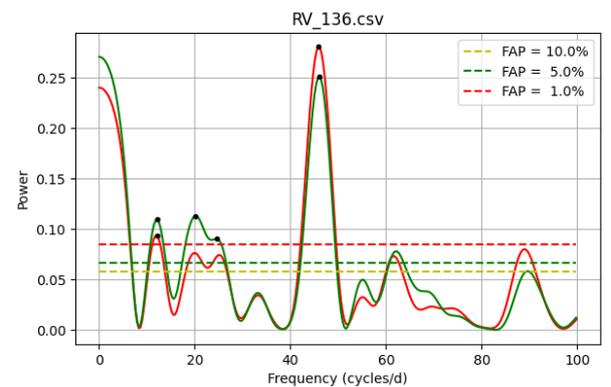
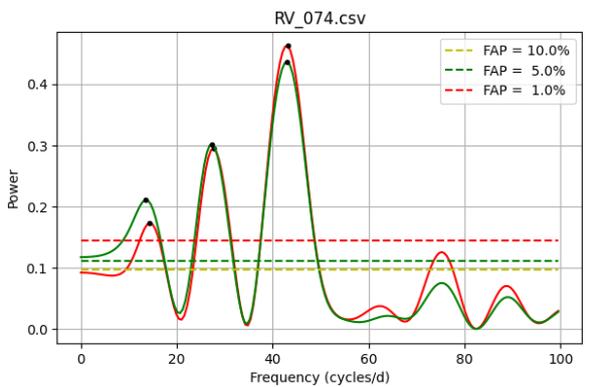
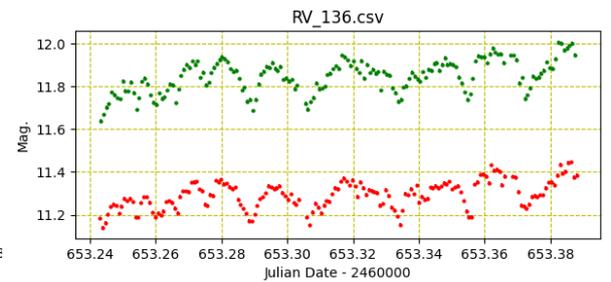
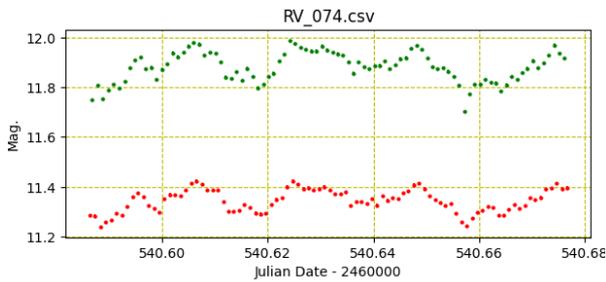
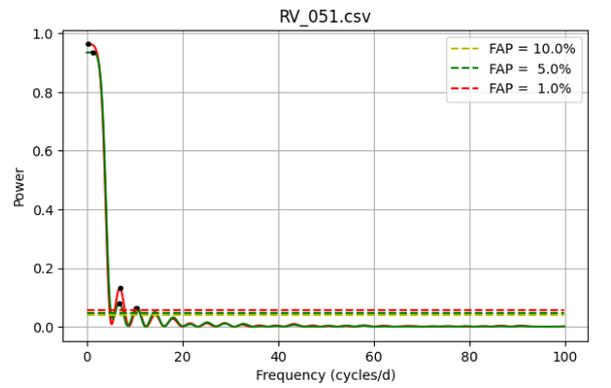
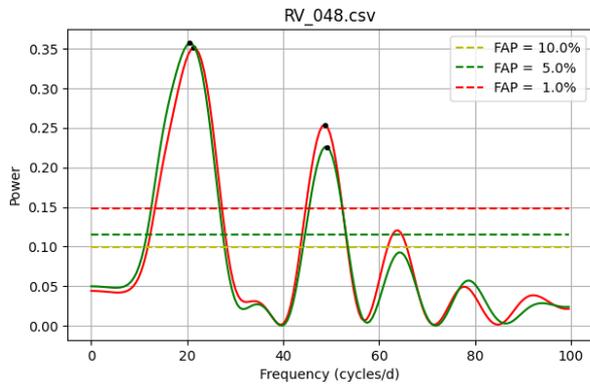
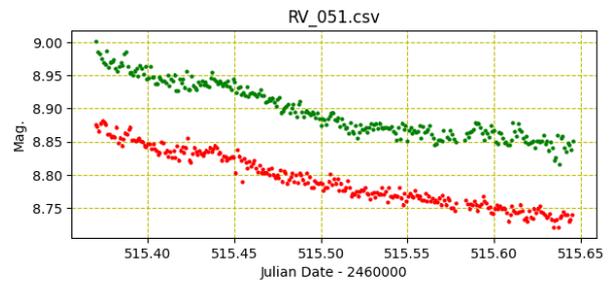
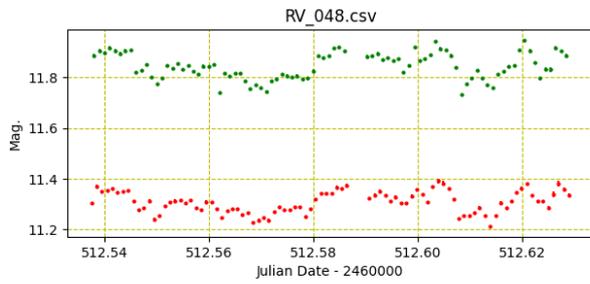
The author used his own Python programmes to perform the power spectrum analysis using the Generalised Lomb-Scargle periodogram (GLS) which is a powerful technique for finding periodic signals in unevenly sampled data, creating a periodogram (power spectrum) by fitting sinusoids to data points. The Python library used to implement the GLS is part of the [PyAstronomy](#) packages.

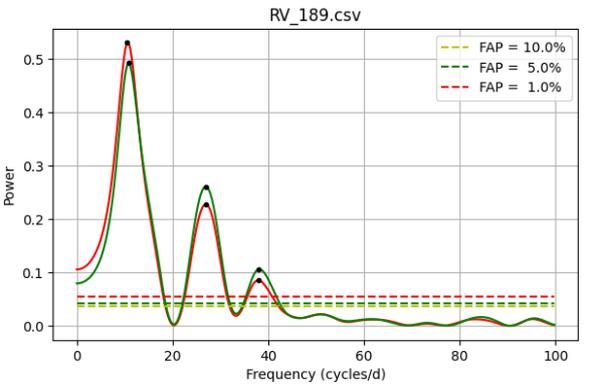
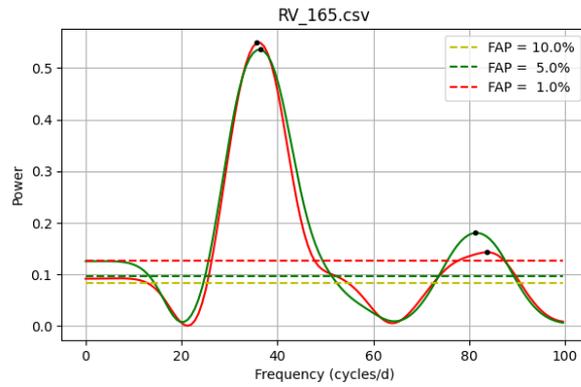
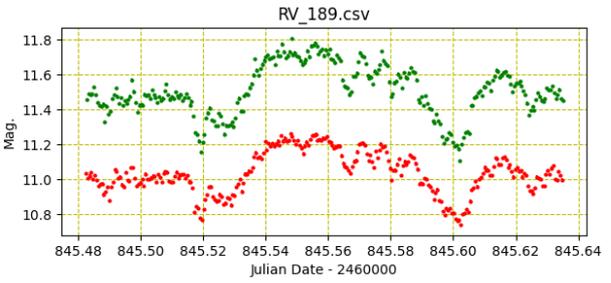
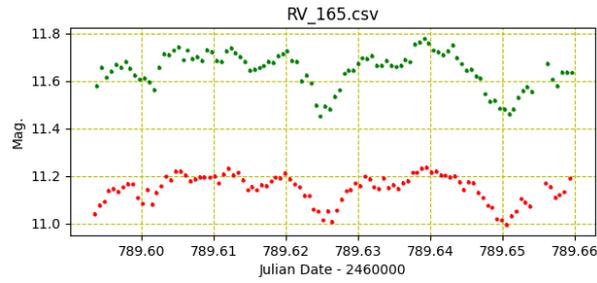
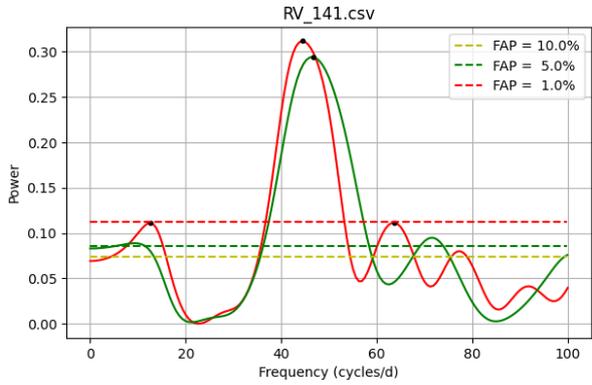
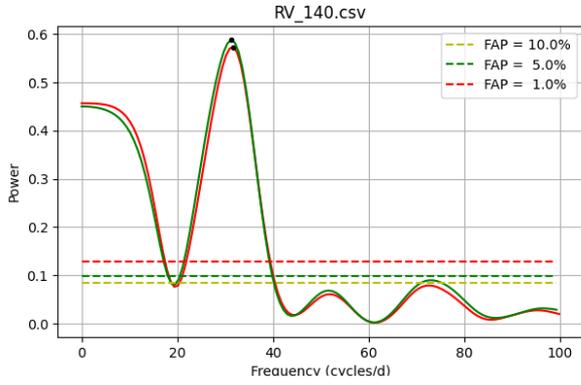
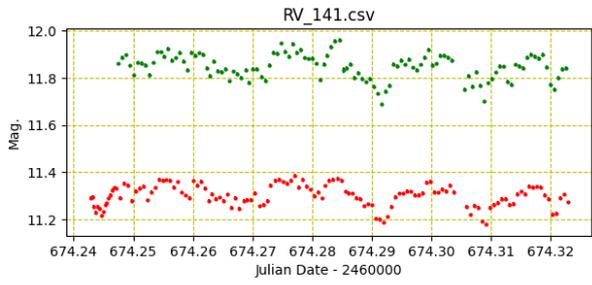
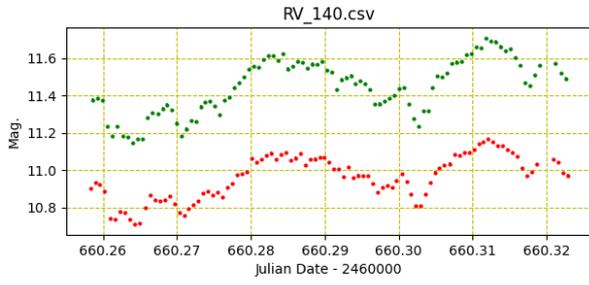
The Generalised Lomb-Scargle periodogram was selected for this analysis because it is specifically designed to handle the irregular sampling patterns typical of ground-based astronomical observations. Unlike standard Fast Fourier Transform methods, which require evenly spaced data points, GLS can effectively analyse time series with gaps caused by weather, equipment issues, and meridian flips. Additionally, GLS does not require interpolation or gap-filling techniques that could introduce artificial periodicities. The algorithm is particularly well-suited to detecting weak periodic signals in the presence of noise, making it ideal for identifying the subtle quasi-periodic oscillations expected in SS Cygni's light curves. The ability to calculate meaningful False Alarm Probability (FAP) levels for irregular data further strengthens the statistical significance of detected periodicities, which is crucial when analysing the large number of individual nightly datasets in this study.

The workflow from raw data to the final GLS results is as follows. All Python scripts were written by the author:

1. Filter and download the data from the BAA photometric database into which the author has already uploaded all data on a nightly basis. This is a convenient way to obtain a comma-separated values (CSV) file of all the data rather than attempting to stitch together hundreds of separate csv files stored on the author's hard disk.
2. Run a custom Python script to read and process the csv file from step 1 to split the data into separate CSV files (one per night) with columns containing the Julian Date, Magnitude, Magnitude error and Filter. This is done by detecting the large gaps during daylight hours.
3. Run a custom Python script to plot each CSV data file for visual inspection. This script also rejects any files with too few data points and also files that have too many gaps. Gaps can be caused by clouds, meridian flips and various technical equipment issues. In this study datasets with less than 30 points are rejected as are datasets containing gaps over 15 minutes. Note that these rejection parameters can be easily varied in the code.
4. Using only the files that pass the tests in step 3, run each nightly file through a custom Generalised Lomb-Scargle algorithm (written in Python). This plots the results of the GLS and also stores the frequency (and period) of the peaks coming out of the power spectrum. The result is a single CSV file containing the details of all the GLS power peaks from all the files.
5. Lastly, plot a histogram of the results from step 4. This is also performed in Python code.

It should be noted that the above workflow produces over 300 light curve graphs (typically with both R and V curves) plus another set of 300+ associated power spectrum graphs arising from the GLS algorithm. Clearly, there are too many graphs to display in this paper and therefore a small sample will have to suffice and Figure 4 shows twelve examples. However, the author has uploaded all the graphs on a webpage at the following URL: <http://python.astro-sharp.com/graphs>.





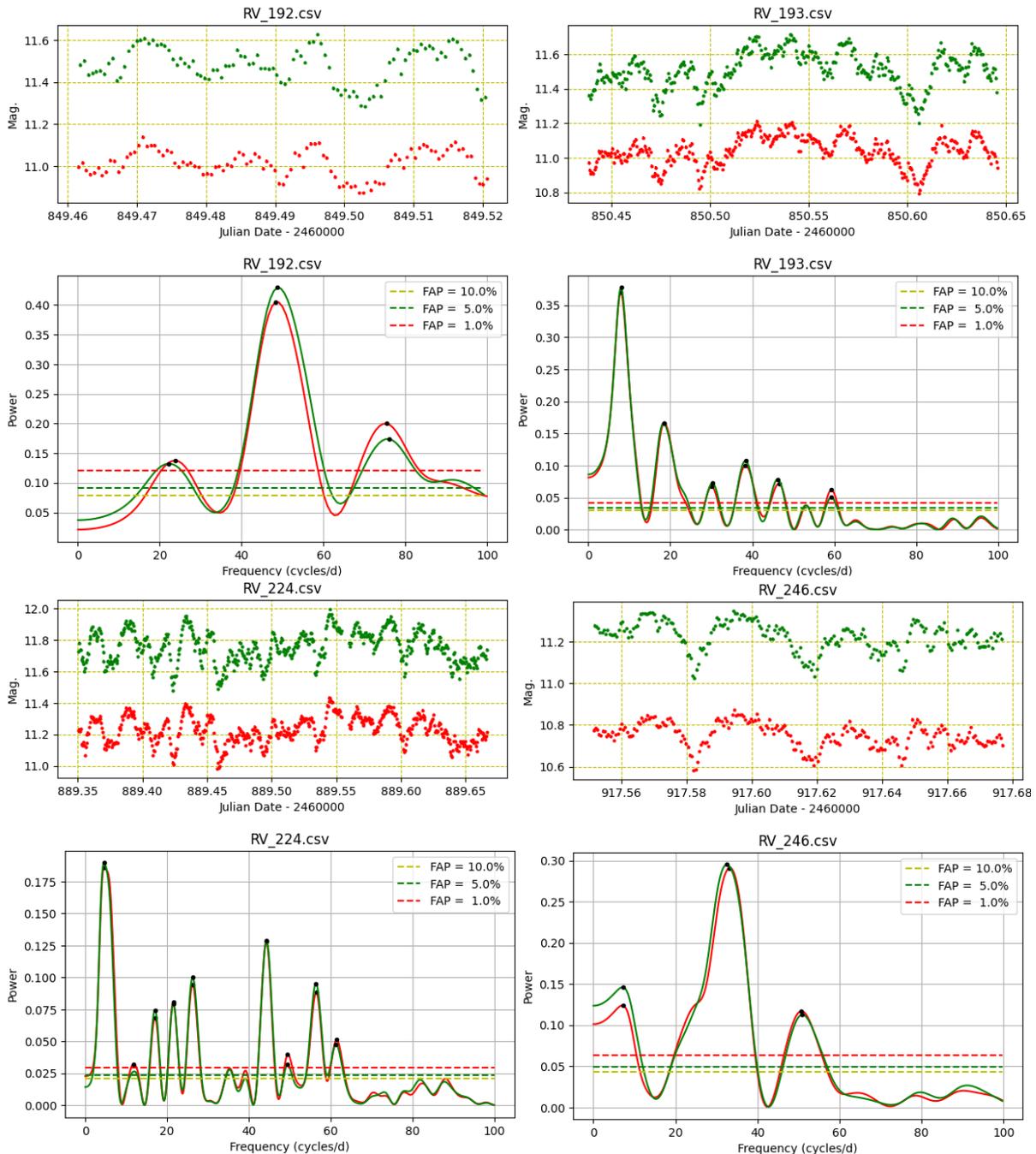


Figure 4. A sample of 12 light curves along with their associated power spectra from the GLS computations. The light curve is shown above the power spectrum for each result. Note that this is a small sample from more than 300 similar results. The titles of the graphs are the file names of the CSV files being processed.

The algorithm for the GLS written in Python has been very thoroughly tested by comparing the results to those produced by the very highly regarded [Peranso](#) software package. The author has compared dozens of randomly selected light curves and has always found the results to be identical to the eye. This includes the FAP levels; see Figure 5. for an example. The main driving force to develop a Python programme was to be able to batch-run the GLS algorithm on hundreds of light curves and to be able to output the hundreds of power spectrum peaks for further analysis. Additionally, the batch can be re-run with different parameters if required.

A low FAP indicates that a peak is unlikely to be generated by noise, representing a significant detection of a frequency component. It is defined as the probability that random noise would produce a peak as high or higher than the observed peak. In the following analysis, only peaks with a power greater than an FAP of 0.01 (1%) are used.

It is mostly the case that the light-curves and the power spectra produced for the R and V filters produce very similar results. The shapes of the light curves are very similar apart from having different absolute magnitude values (i.e., R brighter than V). The shapes of the curves and the peaks from the GLS are also strikingly similar.

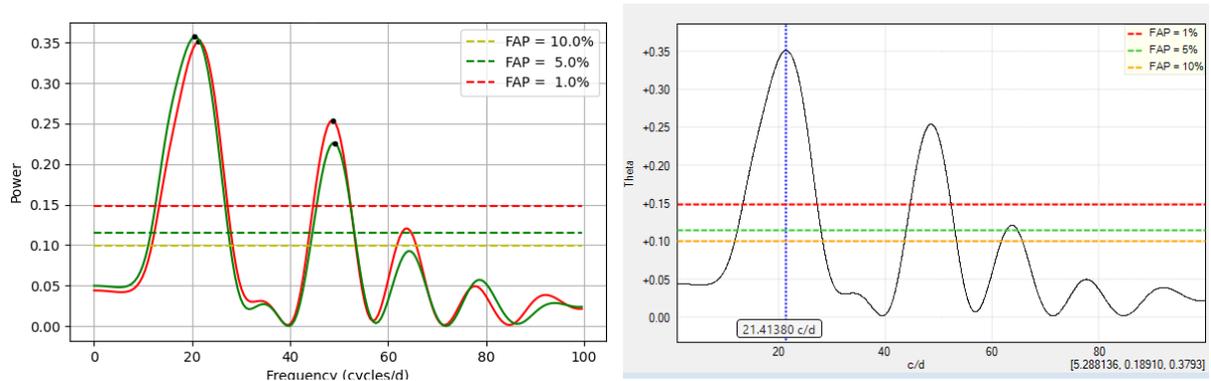


Figure 5. An example of a comparison of the GLS power spectrum results between the author's Python version and the Peranso software. Note that the Peranso graph is only showing the result for the R filter. The results are virtually identical including the False Alarm Probability levels.

The final step in the workflow (described above) is to plot the distribution of the detected peaks in the GLS power spectrum on a histogram graph. Figure 6 shows two histogram plots of periods where the first has a binning width of 5 minutes and the second with 10 minutes. Note that the histograms contain the combined frequency peaks from both the R and V data. The author experimented with separating the R and V results into separate histograms but the resulting plots were so similar that it seemed sensible to combine them. The x-axes of the histograms were extended beyond 4 hours to include the 6.6-hour binary period of SS Cyg which does not show up as a peak on the histogram.

Referring to the right-hand histogram in Figure 6 where the bin size of each bar is 10 minutes the top 4 bars are clustered together and contain 461 power spectrum peaks which is 55% of the total. The period range of the top 4 bars covers a span of 14.6 to 54.5 minutes where the centre of the highest bar is 30 minutes and has a count of 141 peaks.

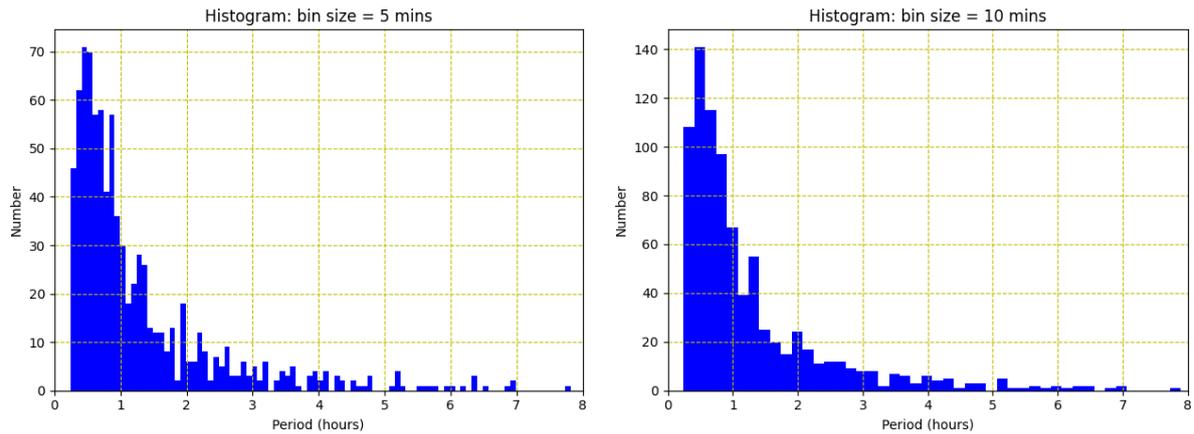


Figure 6. Two histograms showing the distribution of the periods of power spectrum peaks extracted from the data. The period in hours on the x-axis has been limited to 8 hours but the charts are showing 98% of the data and any peaks beyond 8 hours are insignificant.

## Summary and Conclusions

The above analysis of the periodic frequency content of the light curves of SS Cygni shows that there are many QPOs with periods in the range 0.25 to 8 hours (as dictated, in this study, by the sampling frequency due to the cadence of image acquisition). Most of the variability and the majority of the detected power spectrum peaks occur during the quiescent portions, not the outburst portions of SS Cygni's light curve. This would suggest that these really are QPOs and not DNOs which are typically associated with outbursts.

More than 55% of the power spectrum peaks are clustered together in the period range of approximately 15 to 60 minutes (96 to 24 cycles/day). The highest number of peaks in any 10-minute window occur centred on a period of 30 minutes (48 cycles/day). The author has not been able to find other studies that have detected QPOs in this range of periods, probably because the quiescent periods have been under-represented.

## Further Work

The author intends to carry on the regular monitoring of SS Cyg to confirm that the behaviour described above continues. During outburst it should be possible to halve the exposure time and thus look for QPOs or even DNOs at higher frequencies. Broadening the research with potential collaborations or complementary observations could be fruitful.

## Acknowledgments

Thanks to Jeremy Shears and Gary Poyner for their encouragement! ChatGPT was found to be very useful in finding other related studies.

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# In search of pulsations in the X-ray binary A0538-66

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***Pulsations in the X-ray binary A0538–66 were first discovered in December 1980 using NASA’s Einstein Observatory during a bright outburst. This report details our efforts to confirm the presence of these pulsations, which have not been detected since. This follows the observation of renewed visual activity detected in November 2022. Optical and X-ray observations using the NICER and Swift instruments were scheduled for the 16.64-day orbital cycle from November 2022 to February 2023, and a bright outburst in April 2025. We report on the eventual re-discovery of 69-ms pulsations in archived NICER data, confirming them for the first time in over 40 years.***

**Key words:** Optical, Binary, X-ray, Neutron Star, Transient, AAVSO (AID)

## History

A0538-66 (LMC V3434) is a recurrent X-ray transient in the Large Magellanic Cloud that was discovered in 1977 (White & Carpenter 1978) when they detected two X-ray outbursts with the Ariel 5 satellite. Several outbursts from the source, consistent with a period of 16.66 days, were observed with the HEAO-1 modulator collimator (Johnston et al. 1979). The improved HEAO-1 position was then used (Johnston, Griffiths & Ward 1980) to identify its optical counterpart with a bright ( $V \sim 15.7$ ) Be star.

An examination of 85 plates taken with the UK Schmidt telescope at Siding Spring between 1974 and 1979 revealed dramatic flares, separated by intervals of 16.66 days, and synchronised with the X-ray outbursts, confirming the identification (Skinner 1980).

In 1981, Gerald Skinner used archival UK Schmidt and Harvard photographic B-band plates taken between 1915 and 1981, and he determined an orbital period of 16.6515 days (Skinner 1981). In 1980, NASA’s Einstein Observatory, recognised as the first fully imaging X-ray telescope deployed in space, observed this object. During these observations, the monitor proportional counter (MPC) data detected pulsations. The detection confirmed the presence of a neutron star within the system, characterised by 69-millisecond X-ray pulsations (Skinner et al. 1982).

Four consecutive outbursts were observed in late 1981 (Densham et al. 1983). They found that the source can reach a brightness of up to magnitude 12.0. The optical brightening was accompanied by the sudden appearance of very strong H $\alpha$  emission.

## Renewed Activity

The X-ray binary A0538–66 has been on my program since 1996 to detect one of the brighter outbursts. In June 2022, I received an unexpected email from Gerald Skinner, an X-ray astronomer at the University of Birmingham’s School of Physics and Astronomy in the UK, regarding A0538–66.

*“I just wanted to say how grateful I am that you are keeping an eye on A0538-66. I am now retired. During my professional life in X-ray astronomy, I worked quite a lot with this system. I still keep an*

interest in it. The X-ray pulsations from it were always anomalous. I am still awaiting news of renewed activity. I am prepared to use my contacts to get new X-ray observations if it shows signs of another outburst. For a while, a colleague and I used remote telescope time. We made measurements of it from here in the U.K. However, that was tedious and expensive, so I am pleased to get your reports through the AAVSO.” Gerry Skinner.

Gerry explained that he noticed the object’s variability while sitting on a train from Edinburgh to Birmingham.

“I had gone to The Royal Observatory, Edinburgh. I wanted to measure this star on all the UK Schmidt plates. They had an Iris photometer for this purpose, but this was 40 years ago. I arrived and discovered the photometer was broken. I took the first train home. Before leaving, I quickly took Polaroids of some critical plates. On the train, I looked at the photos. It was so obvious, I started writing the Nature letter.”

A few months later, I was surprised to detect some activity on November 17, 2022. The observations indicated that A0538-66 was significantly brighter than usual, with a magnitude of 14.4. I had been monitoring this field for years, and this was the first time I had noticed any bright activity in this star. I emailed Gerry to inform him about the activity. Gerry contacted Keith Gendreau at NASA’s Goddard Space Flight Centre, and Keith arranged for the Neutron Star Interior Composition Explorer (NICER) to commence observations that night. The NICER observations detected X-ray emission from A0538-66, but the flux was relatively low. Despite the lack of high-intensity flux, further monitoring continued.

The recent activity and observations of A0538-66 leading up to the NICER alert are presented in Figure 1. These observations include visual data from the Tetoora Road Observatory and the OGLE-IV I-band database (Udalski 2008) as well as NICER observations. The markers on the figure indicate the predicted times of outbursts based on the ephemerides established by (Rajoelimanana et al. 2017) and (Ducci et al. 2022). The highlighted observation corresponds to the alert issued on November 17, 2022.

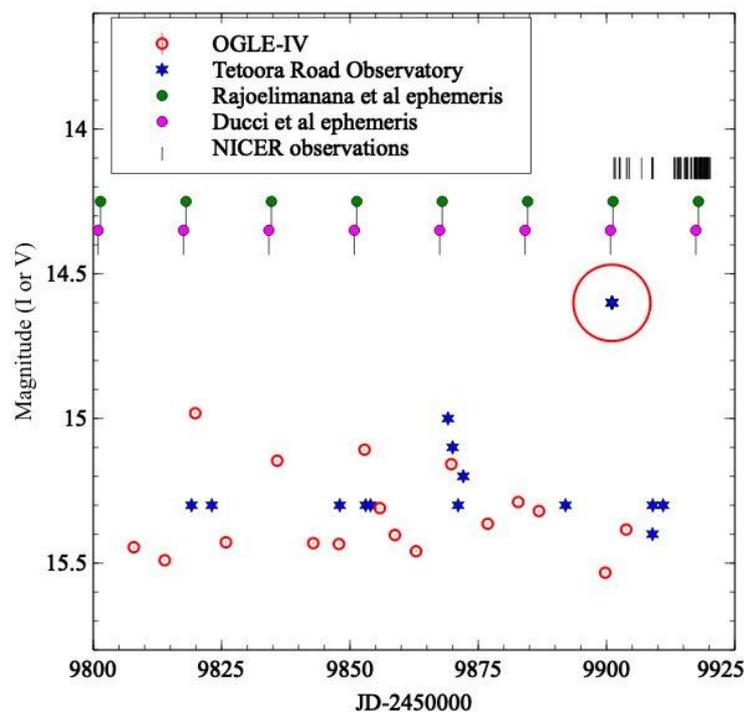


Figure 1. Multi-wavelength plot of the activity leading to the November 17, 2022, outburst. Data include OGLE-IV (I-band), Tetoora Road Observatory (visual), and NICER (X-ray).

The extrapolations based on two ephemerides published by (Rajoelimanana et al. 2017) and (Ducci et al. 2022) suggest that the next phase zero will occur around December 3rd to 4th. Keith Gendreau has scheduled additional NICER high-cadence monitoring to cover the entire orbital period from December 3rd through December 5th. To alert the wider astronomical community, an Astronomer's Telegram (ATel #15781) was issued, highlighting the renewed activity and the upcoming orbital maxima (Figure 2).

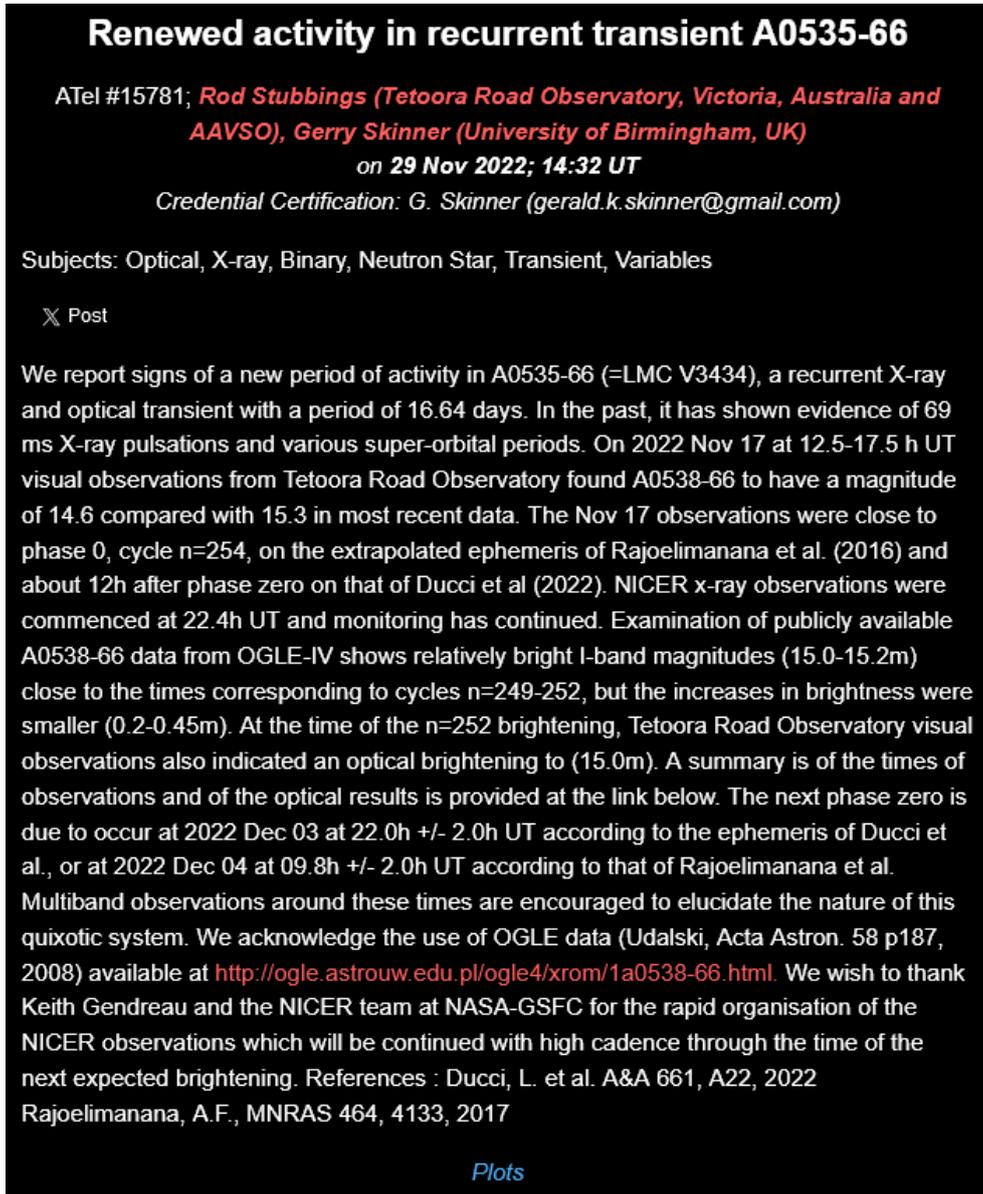
The image is a screenshot of an Astronomer's Telegram (ATel #15781) with a black background and white text. At the top, the title "Renewed activity in recurrent transient A0535-66" is displayed in a bold, white font. Below the title, the author information is listed in red text: "ATel #15781; Rod Stubbings (Tetoora Road Observatory, Victoria, Australia and AAVSO), Gerry Skinner (University of Birmingham, UK)". The date and time of issuance are given as "on 29 Nov 2022; 14:32 UT". The author's contact information, "Credential Certification: G. Skinner (gerald.k.skinner@gmail.com)", is shown in white text. The subject line, "Subjects: Optical, X-ray, Binary, Neutron Star, Transient, Variables", is also in white. A small icon of a crossed-out post symbol is followed by the word "Post". The main body of the telegram is a paragraph of white text reporting on the renewed activity of the transient A0535-66 (also known as LMC V3434). It details observations from Tetoora Road Observatory on November 17, 2022, and mentions NICER x-ray observations. The text concludes with a link to OGLE data and a list of references: Ducci, L. et al. A&A 661, A22, 2022 and Rajoelimanana, A.F., MNRAS 464, 4133, 2017. At the bottom right of the text area, the word "Plots" is written in a blue, italicized font.

Figure 2. Astronomer's Telegram ATel #15781, issued to alert the community of renewed activity.

## Observations

Monitoring of A0538–66 continued from November 17, 2022, to February 2023. Six outbursts were detected over this time frame. Optical and X-ray observations from NICER were obtained for each 16.4-day orbital cycle.

In December 2022, we sought to address the potential contamination from the nearby bright X-ray source LMC X-4. Gerry submitted a Swift Target of Opportunity request for this outburst as soon as possible, and it was approved. The first Swift observation on December 22 confirmed that the emission originated solely from the optical position of A0538–66, though the signal remained weak and short-lived. Additional Swift observations were scheduled for the next anticipated outburst expected to occur in 16.4 days, from January 6 to January 7, 2023. Numerous NICER observations have also been planned for that period. On January 6 and 7, 2023, Swift UVOT captured a V-magnitude of  $14.807 \pm 0.033$ . (Figure 3)

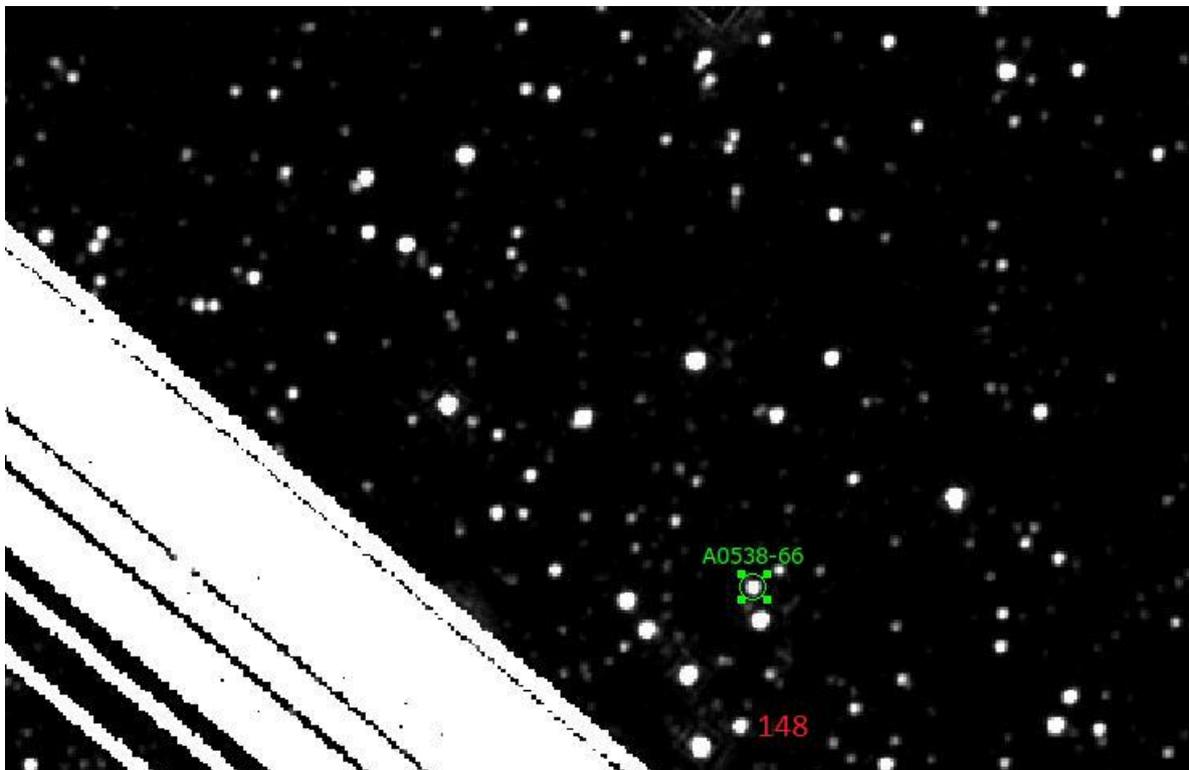


Figure 3. Swift UVOT V-band image from January 6 & 7 observations. The comparison star 14.8 shown has been used for visual observations.

The Swift observations on January 6 and 7 proved particularly significant. The strongest X-ray detections occurred during these sessions, which took place well after phase zero. It was during this specific window that the 69-ms pulsations were eventually identified in the archived NICER data. A preliminary analysis of the Swift data is illustrated in Figure 4, along with the visual and V magnitude data compared to the Ducci phase zero.

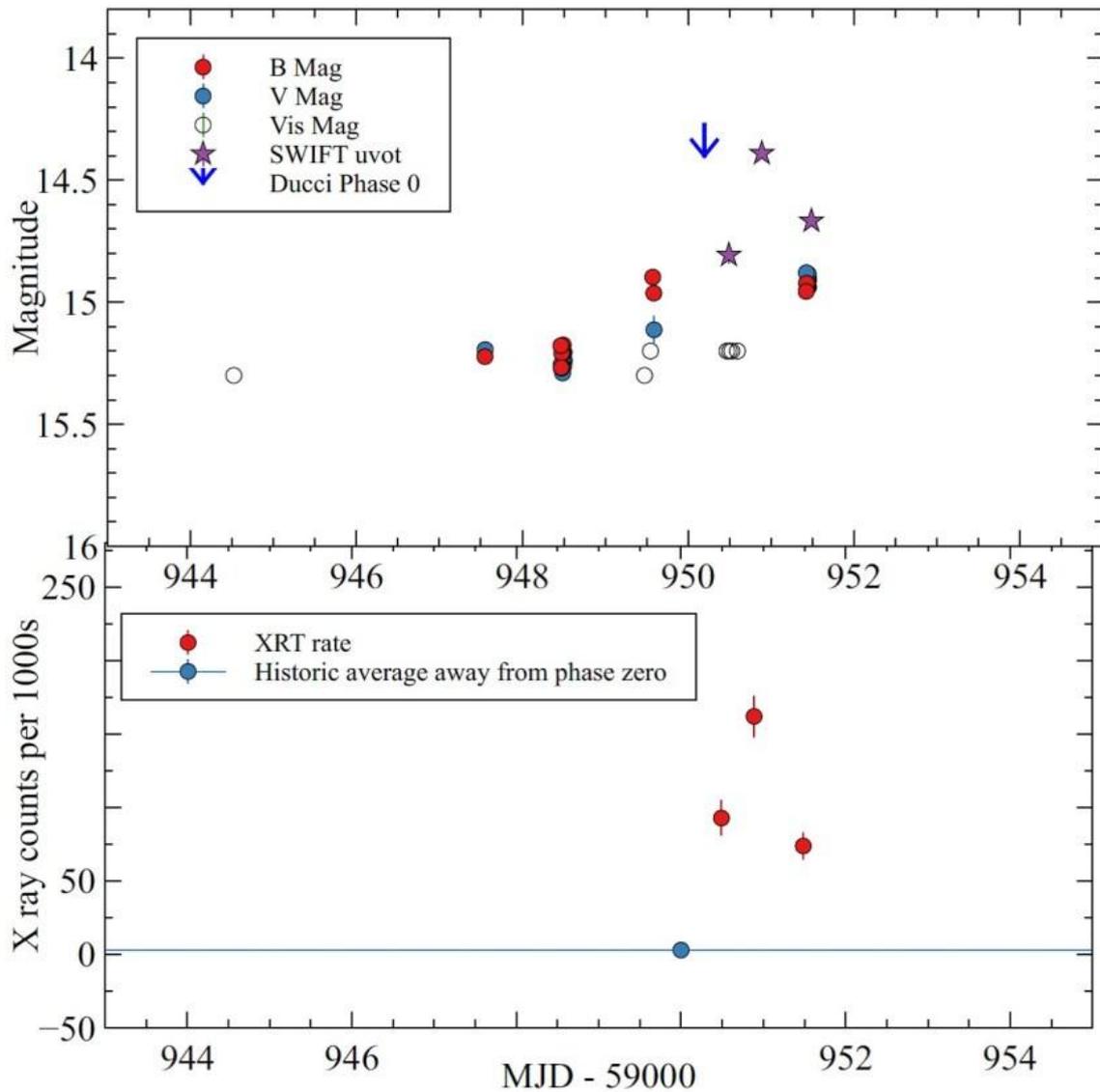


Figure 4. Analysis of Swift XRT, UVOT and visual data compared to the Ducci phase zero, showing the activity on Jan 6 & 7 away from phase zero.

Following the Swift observations, a discrepancy was noticed between the visual sequence and the Swift data. To address this issue, I contacted Sebastian Otero from the AAVSO, who organised a new visual sequence for A0538-66. This adjustment reduced the discrepancy with the Swift data.

On January 22, the peak visual brightness during this cycle was magnitude 14.0, the brightest thus far. Dr Jamie Kennea at NASA's Neil Gehrels Swift Observatory took part in an initial request for observations. He stated, "We could examine it with Swift today if you think it's worthwhile." Consequently, another observation was scheduled for January 22. Swift observations showed that A0538-66 was significantly brighter in X-rays than it had been on January 6th and 7th.

The presented plot illustrates the visual and Swift observations. It highlights the correlation between peak brightness and the ephemeris by Ducci et al. Notably, the visual peak brightness occurred prior to the predicted ephemeris. (Figure 5)

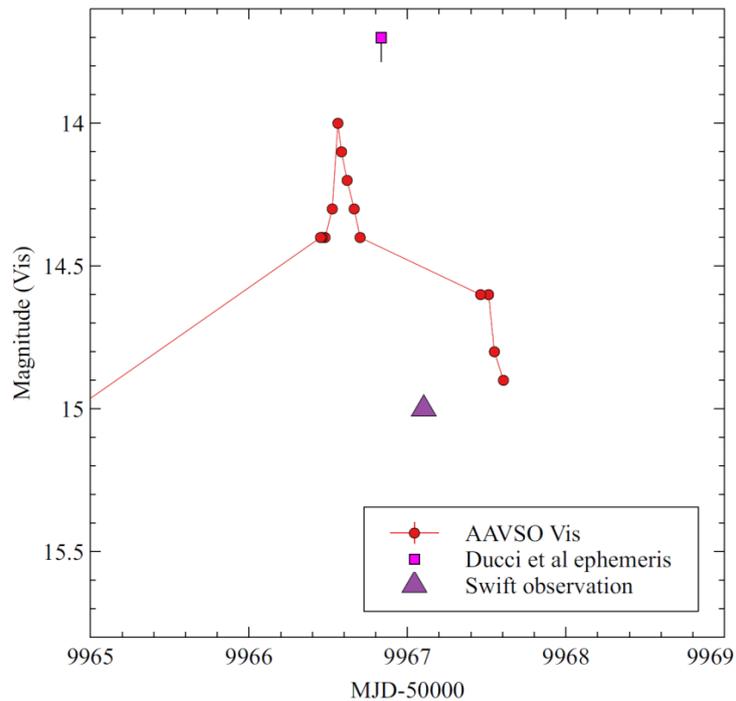


Figure 5. Visual observations alongside Swift data, compared to the ephemeris of Ducci on January 22, 2023.

The next phase zero was on February 8, 2023. Due to the increased X-ray activity from the previous outburst, further NICER observations were scheduled. Keith Gendreau provided real-time images showing significant flaring activity with high variability (Figure 6). The initial analysis of the full data segments still found no significant pulsations during this outburst.

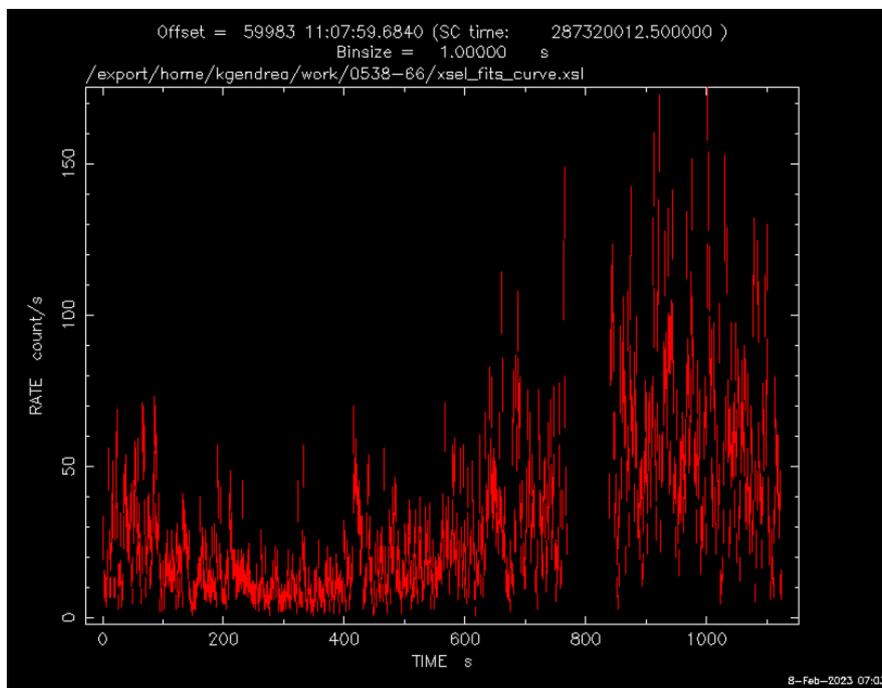


Figure 6. High-cadence NICER light curve (1-second bins) showing genuine flaring activity during the February 8, 2023, cycle.

## The April 2025 Outburst

Following the February 2023 events, the source returned to a quiet phase. This period of inactivity lasted several months until a few outbursts occurred between October 2023 and February 2024. No NICER observations had been planned or scheduled for this period leading up to April 2025.

A significant bright outburst was recorded on April 16, 2025, reaching magnitude 13.0. This brightness was comparable to the historical levels documented in 1981 (Densham et al. 1983). I monitored the system throughout the night and alerted Keith Gendreau and Gerry Skinner. While NICER targeted the event on April 17, visual observations showed the star had already faded to 14.4, indicating that NICER observations missed the extremely bright outburst. Visual observations showed a further decline to 15.0 by April 18. This suggests the peak brightness was very brief. (Figure 7)

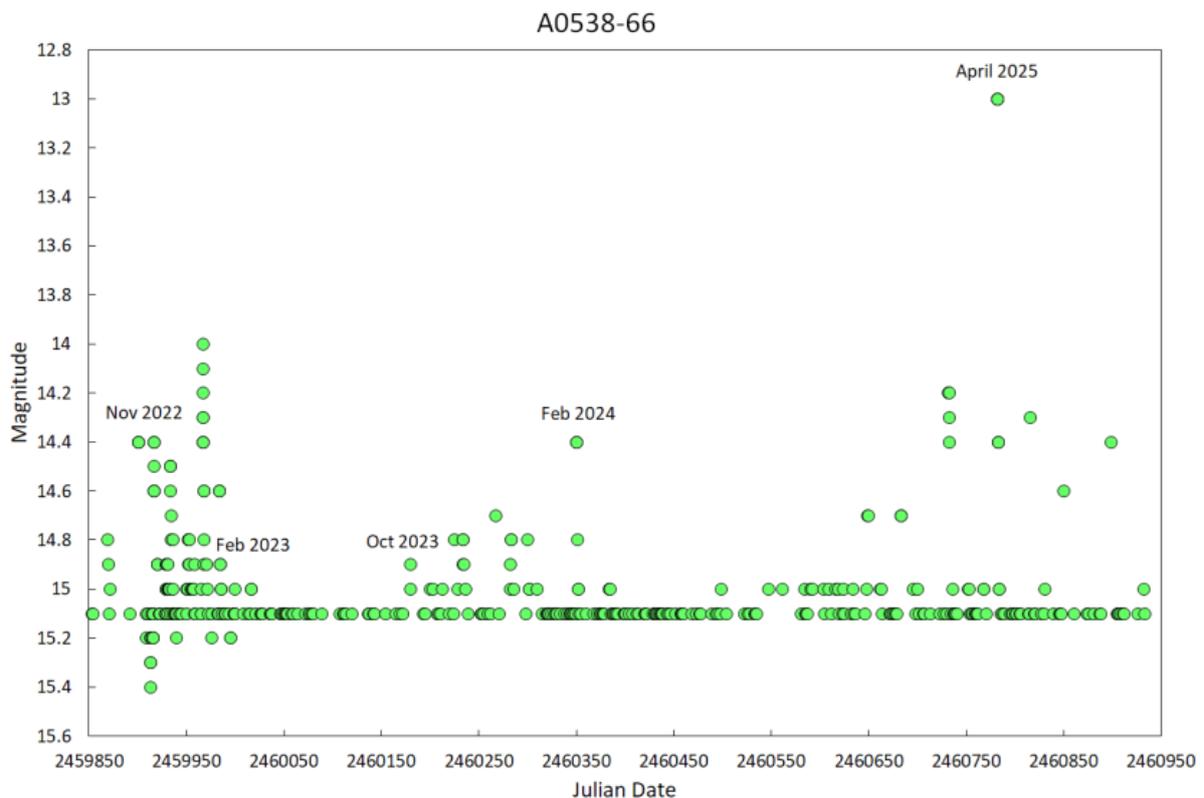


Figure 7. Long-term visual light curve of A0538-66 showing the sequence of outbursts and subsequent quiet phases, including the major April 2025 event.

## Pulsations Detected

In July 2025, I received an email from Gerry Skinner regarding a newly published paper on A0538-66 by Ducci & Mereghetti (2025). The researchers analysed the public archive of NICER data generated by our campaign from November 2022 to February 2023, as well as the 2025 alert. While real-time analysis of the full datasets had been inconclusive during our observations, Ducci and Mereghetti used a technique that focused on short sub-segments of the data. By examining an 11-minute window of data captured around January 9, 2023, they successfully identified the 69-ms X-ray pulsations.

Interestingly, this detection occurred during a relatively faint outburst and decline phase, rather than at the peak of the brightest outbursts (Figure 8). This marked the first detection of the pulsations in over 40 years, validating the observations originally reported by Gerald Skinner in 1982. A few months later, in September 2025, another X-ray pulsation was observed with the XMM-Newton (Ducci et al. 2025). The pulsations have only been detected three times since 1980.

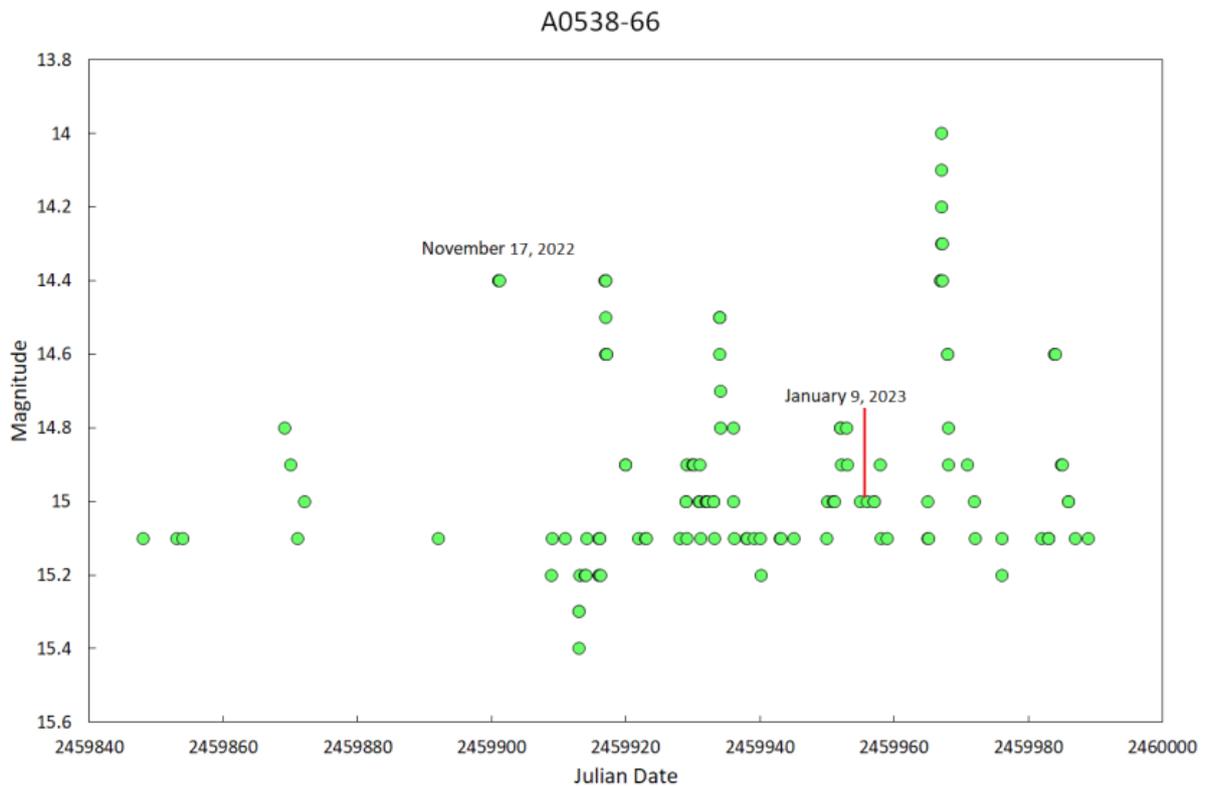


Figure 8. Visual observations detailed from renewed activity on November 17 to February 2023. The location of the 69-ms X-ray pulsations discovered on January 9 is shown relative to the visual light curve covering this period.

## Conclusions

The rediscovery of pulsations in A0538-66 highlights the critical role of long-term visual monitoring in triggering high-energy space observations. While the most intense outbursts did not immediately yield the signal, the persistent collaborative effort provided the necessary data for a successful archival search. For Gerry Skinner, the result is a significant validation of his work four decades ago.

## Acknowledgements

I wish to express my sincere appreciation to Gerry Skinner (University of Birmingham) for his expertise, detailed figure plotting, and coordination of space telescope observations. We acknowledge Keith Gendreau and the NICER team (NASA GSFC). Jamie Kennea, Neil Gehrels Swift Observatory, for arranging observations. Thanks to Sebastian Otero (AAVSO) for sequence management and the OGLE team for data access.

The contributions of the AAVSO observer community are gratefully acknowledged. Their photometric data and metadata resources were used in this study and were made available through the AAVSO scientific archives.

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# Eclipsing Binary News

Des Loughney

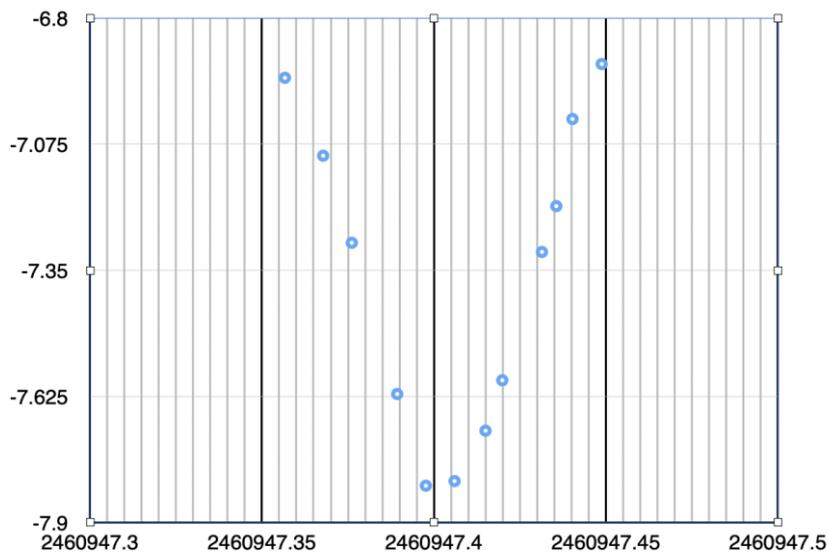
[dloughney690@gmail.com](mailto:dloughney690@gmail.com)

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## RZ Cas

It was possible to study an eclipse of RZ Cas on the 28th of September 2025. Below is a light curve of the primary eclipse with measurements derived by DSLR photometry. The vertical axis is magnitude, and the horizontal axis is Heliocentric Julian Date. The light curve is the standard light curve for a primary eclipse of RZ Cas. According to the Krakow website the predicted time of mid primary eclipse was HJD 2460947.4228. The observed time of mid primary eclipse is HJD 2460947.4025. This is about 29 minutes earlier than predicted.

The Krakow period of 1.19525 days dates back to 2002. The period that can be calculated from the TESS data of May/June 2024, that is held on the MAST site, is 1.19585 days, RZ Cas is known, as an active system undergoing mass transfer, to fluctuate in period.



## Bob Nelson Eclipsing Binary O-C database.

### A note from Robert Jenkins...

Most astronomers in the eclipsing binary world would have heard the name Dr Robert H Nelson – Bob to his friends. Sadly, Bob died on 2<sup>nd</sup> November 2022 after a long battle with cancer.

Bob was a prolific investigator of eclipsing binary systems for over 25 years, having published well over one hundred papers on the subject. He is probably best known for his database of "Eclipsing Binary O-C files" which is hosted on the AAVSO and Southwest Research Institute websites plus software, especially Minima 27, hosted at Variable Stars South and SWRI.

I got to know Bob when I found his O-C database on the AAVSO website. A question about some data several years ago made me realise that Bob had established the database, primarily for his research, and was managing and updating it on his own. I offered to help and have spent many years collecting data and updating his workbooks. We never met in person but our regular Skype meetings (after we had sorted out our time differences) lasted for hours.

Bob asked me to take over the work on the database, warning me that it is more work than it first appears and can get addictive; and he was right. He gave me licence to modify it any way I want, and I have made some minor changes, but I retain the spirit of his work.

For those who do not know, the Nelson Database is a collection of O-C minima times from most published articles and personal files from researchers from around the world (I would like to say all but I am sure there are some journals I have not sourced). The data includes BAA observations amongst many others. The observations are combined and various levels of analysis are undertaken. Most importantly, the database is freely available from AAVSO and SWRI and files can be downloaded for personal use. The key advantage is that information (from as early as late 1800s in a few cases) is in one place and researchers do not have to do literature searches for the minima times.

Updates to the database are added to the websites twice a year – February and August. I am happy to receive requests for latest information that I may have found after the last update and regularly do from researchers, particularly university students. In addition to the published database, I have collected minima times on star systems that are yet to be recognised as binary or they have no published periods or epoch – this makes analysis impossible so are not included in the published versions.

In 2025, 6710 new O-C minima observations were added to the database, into 1215-star systems, two hundred of which had no previous data.

While the ethos of the database is to include published data (to ensure reliability) I am happy to include observations from recognised researchers prior to publication for inclusion in the database. BAA members, like Tony Vale, are included in that early publication where it does not compromise institutional and journal publication criteria. Early inclusion allows other researchers to get earlier access to data.

I am always looking for new sources of data. If you know of any sources, published or not, of O-C minima data, I would appreciate gaining access.

I am happy to share information with observers and discuss any matters concerning the database – be aware though that I live in South Australia and there may be a delay in communications.

Robert Jenkins  
Bob Nelson Database Administrator  
[robynabara@ozemail.com.au](mailto:robynabara@ozemail.com.au)

AAVSO website link - (<https://www.aavso.org/bob-nelsons-o-c-files#Peg>)

Southwest Research Institute website link – [Eclipsing Binary Observers Home Page \(swri.edu\)](http://www.swri.edu)

Variable Stars South website -  
<https://www.variablestarssouth.org/resources/bob-nelsons-software-tools/software-by-bob-nelson>.

## The AAVSO International Variable Star Index (VSX)

<<https://vsx.aavso.org/>>

In December 2025 I had a valuable online meeting with Sebastian Otero who works for the AAVSO. He administers the VSX database. The wealth of information available means that it is an important source for all eclipsing binary observers and contains a detailed search engine. More functions are available to those people who register with VSX.

I have now registered. I looked at the data available for a couple of my favourite EBs. One of these is RZ Cas. I see that BAAVSS publications are monitored to update the VSX. Included in VSX is the article by Chris Lloyd published in 2025 on 'The period behaviour of the bright Algol binary RZ Cas'. It was good to see that this EB has its proper classification as being a member of the EA DSCT class.

The DSCT class is a rare group of variable stars. There are around 100 or 200 known systems identified as of late 2024, many thanks to space-based surveys like TESS. RZ Cas has a pulsating primary star. The pulsations have a period of 0.0155771 days and an amplitude of 0.02 mag.

It is also good to see there is a section on the Revision History of the data for RZ Cas. Top of the list is the period as described in BAA VSSC 203.

I also looked at the data for U Cep. I was surprised to see that the variability type is DPV/EA. I have never come across before the DPV classification. It means 'Double Period Variables.' U Cep is a semidetached eclipsing binary with an optically thick disk around the gainer that experience regularly cycles of mass loss into the interstellar medium and are characterised by orbital photometric variability in time scales of a few days and a long photometric cycle lasting roughly 33 times the orbital period.

With the information that is now available through VSX it is easier to find out which EB's are 'active' and are worth in-depth study. A new light has been cast on familiar systems.

## Totally eclipsing binary UZ Draconis inspected with TESS

A paper on this subject has been reported at <https://arxiv.org/abs/2510.27389> on 31/10/25.

UZ Dra is an EA/DM system with two stars of similar size and therefore similar primary and secondary eclipses. The depth of the primary eclipse is 9.9 to 10.7 magnitude and the secondary 9.9 to 10.6. The period is 3.2613024 days.

The TESS data is reported in the diagram below (Figure 1). It is hard to understand why the system is termed a totally eclipsing system as the neither of the eclipses has a flat bottom. The eclipses are partial. The TESS data shows that the system is not an 'active' EB. The stars are sufficiently separated despite having a short period, they do not have an accretion disk with possible hot spots. In addition, there does not appear to be gravitational distortion of either star or variations caused by reflection effects. It would be useful if the data in VSX on this system included information on the significant secondary eclipse.

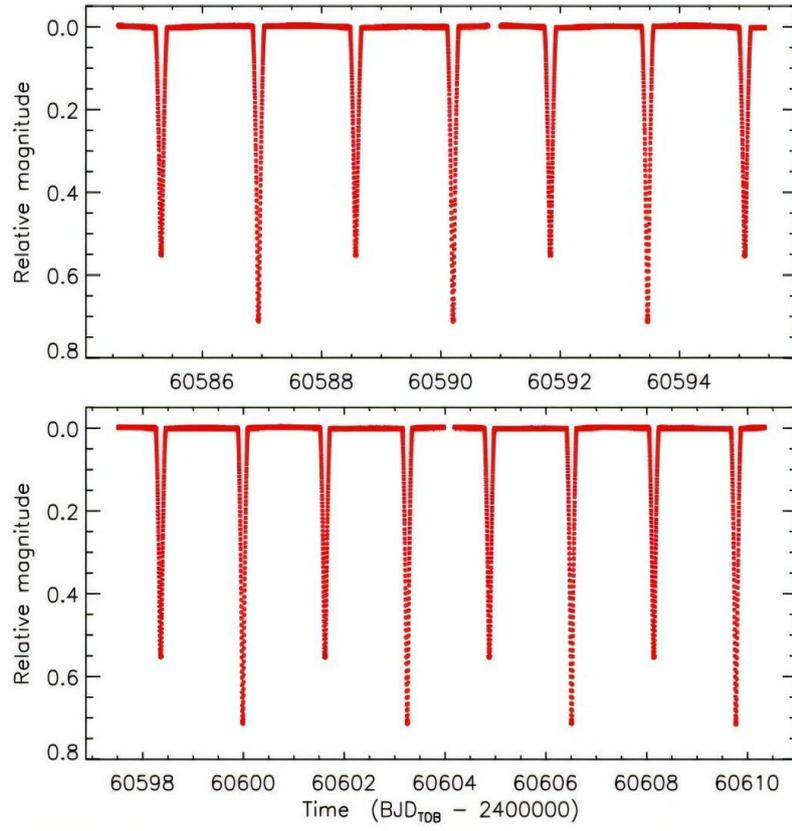


Figure 1. UZ Dra

## Recent Minima of various Eclipsing Binary Stars - 11

Tony Vale

[tony.vale@hotmail.co.uk](mailto:tony.vale@hotmail.co.uk)

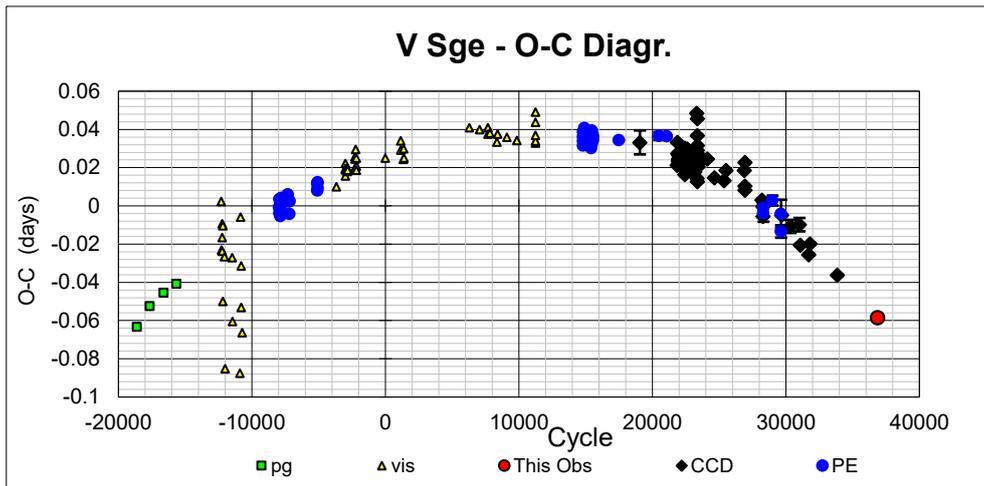
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***This report lists recent timings of minima of various eclipsing binaries. The observations from which the timings were obtained have all been posted to the BAAVSS and the AAVSO photometric databases.***

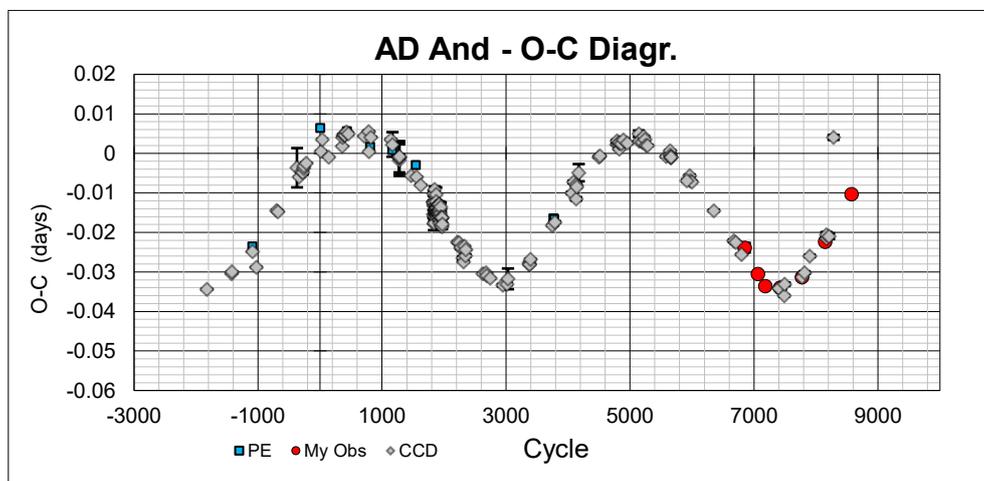
<u>Star</u>	<u>HJD of Min</u>	<u>Filter</u>	<u>Error</u>	<u>Type of Minimum</u>
U Gem	2460734.46416	V	0.001	Primary
EM Cyg	2460900.46333	V	0.001	Primary
V704 Cyg	2460905.43911	V	0.0015	Secondary
V388 Cyg	2460915.55017	V	0.0005	Primary
V608 Cas	2460917.45050	V	0.0025	Primary
V Sge	2460933.40773	V	0.0005	Primary
AM Her	2460935.57144	V	0.002	Primary
CW Cas	2460940.50976	V	0.0002	Primary
SU Cep	2460956.40095	V	0.0002	Primary
AD And	2460956.59537	V	0.0005	Secondary
PV Cas	2460978.34219	V	0.0002	Secondary
WZ Cep	2460988.54558	V	0.0005	Secondary
CW Cep	2460990.50812	V	0.001	Secondary
V765 Cas	2460997.41924	V	0.0007	Primary
DK Cyg	2461005.45416	V	0.0003	Secondary
SX Aur	2461009.62447	V	0.0002	Primary
EG Cep	2461043.44823	V	0.002	Primary
TT Aur	2461044.38240	V	0.0005	Primary
Z Dra	2461044.60288	V	0.0008	Primary

The observations were made using a 102mm refractor and an ASI 183MM-Pro cooled mono CMOS camera. The minimum timings of EG Cep, TT Aur and Z Dra were extracted using Peranso. The others were extracted using Bob Nelson Minima software. O-C diagrams are based on Nelson Database of Eclipsing Binary O-C Files (<https://www.aavso.org/bob-nelsons-o-c-files>). The database is maintained by the AAVSO and is updated a couple of times a year.

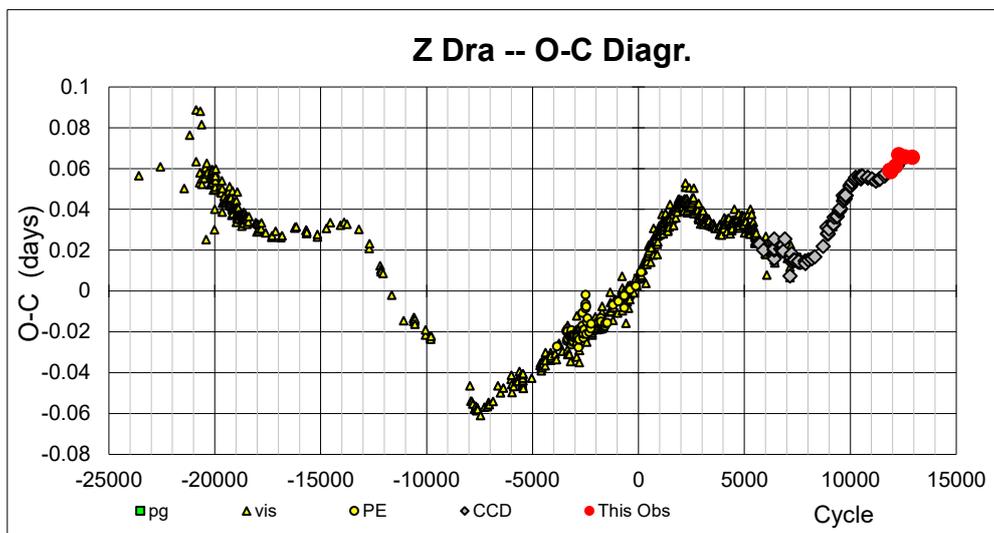
V Sge is classified as a variable star of type CBSS/V + E according to VSX. This means it is a close binary, supersoft (i.e. soft X-ray) source, sub type V Sge which shows eclipses. The time of minimum observation reported above is plotted in red on O-C diagram shown here. The diagram covers a period of about 80 years and over that time the orbital period has clearly been decreasing. According to a prediction by Schaefer, Frank & Chatzopolous (2020), the accretion rate is increasing with a doubling time of 89 years leading to a shrinking orbit and ultimately, a merger of the components in  $2083 \pm 16$  years. V Sge is certainly an unusual CV. It is 100 times more luminous than all other known CVs and the mass of the companion star is 3.9 times the mass of the white dwarf.



AD And is classified in VSX as an EB type eclipsing binary. These stars typically have ellipsoidal components and continuously varying light curves between eclipses. I first observed AD And on 12<sup>th</sup> February 2021. That observation and all those I have made since are shown in red in the accompanying O-C diagram. The sinusoidal shape of the curve indicates the presence of a third body in the system causing the orbiting pair to oscillate. As their distance from us varies, the light travel time effect causes variations in the orbital period as seen from Earth. From the diagram, this oscillation has a period of 12.1 years. A value of 0.0188 days was obtained for the amplitude of the oscillation. This corresponds to a variation in the distance to AD And of about 6.5 AU. During the time I have been following it, the system has passed through its closest approach to the earth and is now receding from us.



Z Dra is classified in VSX as an EA/SD. EA means it is an Algol type eclipsing binary with circular, or only very slightly ellipsoidal components and unchanging or only very slightly changing light curves between eclipses. SD means the surface of the secondary is close to the inner Roche lobe. Since my first observation on 22<sup>nd</sup> January 2022, I have made a further five observations including the one listed above. Once again, these are shown in red in the O-C diagram. The diagram differs significantly from that of AD And. Abrupt period changes are taking place, both increases and decreases in the period are apparent. During the time I have been observing it, it appears to have undergone another one of these abrupt changes, although more observations will be needed to be sure of this. These sudden changes in both directions can be difficult to explain and often magnetic interactions between the components are thought to be involved. However, according to J. Z. Juan et al, (2014) no strong magnetic activity is reported in the literature for Z Dra. Instead, they suggest the appearance of the O-C diagram can be explained by the presence of three or four companions orbiting the eclipsing pair.



### References:

Yuan, Jinzhao & Senavci, Hakan & Selam, Selim & Gümüş, Damla. (2014). Dynamical analyses of the companions orbiting eclipsing binaries II. Z Draconis with four companions close to 6:3:2:1 mean motion resonances.

Bradley E. Schaefer, Juhan Frank, and Manos Chatzopoulos. [Binary Star V Sagittae will Explode as a very Bright 'Nova' by Century's End](#)

Peranso ([www.peranso.com](http://www.peranso.com)), a light curve and period analysis software.

# My first observations of Eclipsing Binaries using a Smart Telescope

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***This short article describes some of my experiences to date of observing eclipsing binaries with a smart telescope. Note that this is neither an objective review nor a definitive 'how to' article!***

The Variable Star Section meeting on 25<sup>th</sup> October 2025 included the presentation *Targets for Smart Scopes*, by Dr Christopher Lloyd, which is described in circular [206](#).

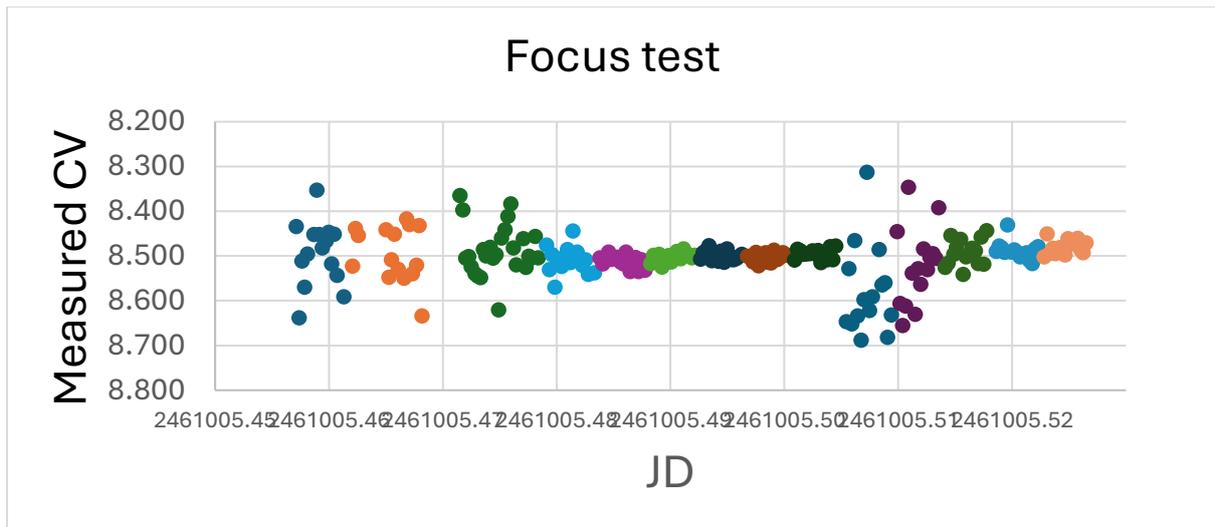
The current equipment I use at my observatory in east Leicestershire for observing variable stars is the [2" Titan](#). This works well, but it can take up to half an hour to set up. It is also not a go-to system. Once on target it will track, but finding the relevant variable in the first place, using maps and a finder 'scope, can also take quite a while. The idea of using a 'smart' telescope had not occurred to me before, but the potential benefits – mainly of speed setting up and finding the object star – appealed. It would also be available if my old equipment were to fail.

After investigating online I decided to get the ZWO 30mm f5 [Seestar S30](#). This particular model was chosen because its field of view (1.22° x 2.17°) was wide enough that I could use the same comparison stars I use with my [2" Titan](#) for observing my program eclipsing binaries. The smaller aperture was not considered to be an overriding factor although it might be problematic for the fainter objects that I currently observe.

The S30 comes with a small tripod for alt-az mode, or it can be attached to a larger tripod (not supplied, and needing the relevant connectors) for equatorial mode. The free to download control app runs in Android, which I use on a tablet, or iOS, and requires both a Wi-Fi connection to the S30 (which is itself a hub, simple to log into) and a Bluetooth connection. Setting it up in either mode was fairly quick and simple, with the app providing information about what adjustments are required to correctly polar alignment the instrument.

The app has built in catalogues of deep sky objects, but not one of variable stars. However, it can be set to point to any required RA and Dec and it is possible to build up your own catalogue of variables based on their coordinates. Images are automatically calibrated with darks but not flats, but this can be done afterwards as required.

Two big issues that I have had were with focus and 'dithering.' The S30 defaults to autofocus for deep sky imaging. The focus can be adjusted manually to give the best FWHM for photometry, and experiments can help to determine that which gives the least scatter – such as in the following example. This starts with in focus images and then change in steps, first with negative and then with positive changes from the in focus position.



Exposures are not continuously adjustable, but can be set to 10s, 20s, 30s or 60s in the ZWO app that I have, so this could also restrict the choice of observable fainter variables, but a more versatile alternative is discussed below.

'Dithering' is a process where the centre of the field of view is changed every few images by a random number of pixels in a random direction to spread out any faults with the CMOS chip so that they don't appear in the stacked, processed images which the S30 generates automatically. Fortunately, the original individual images are also stored unchanged as standard FITS files in its internal memory and can be downloaded via the inbuilt USB connector for later photometry or other processing.

The dithering distances can vary from a few pixels to more than 200 pixels, while the program which I use for photometry (AIP4WIN) cannot follow this in automatic tracking mode. Consequently 'manual' tracking mode needs to be used, re-identifying the comparison star (C1) every few frames – which was for more than 670 images of V1342 Cas on December 29 2025, see below.

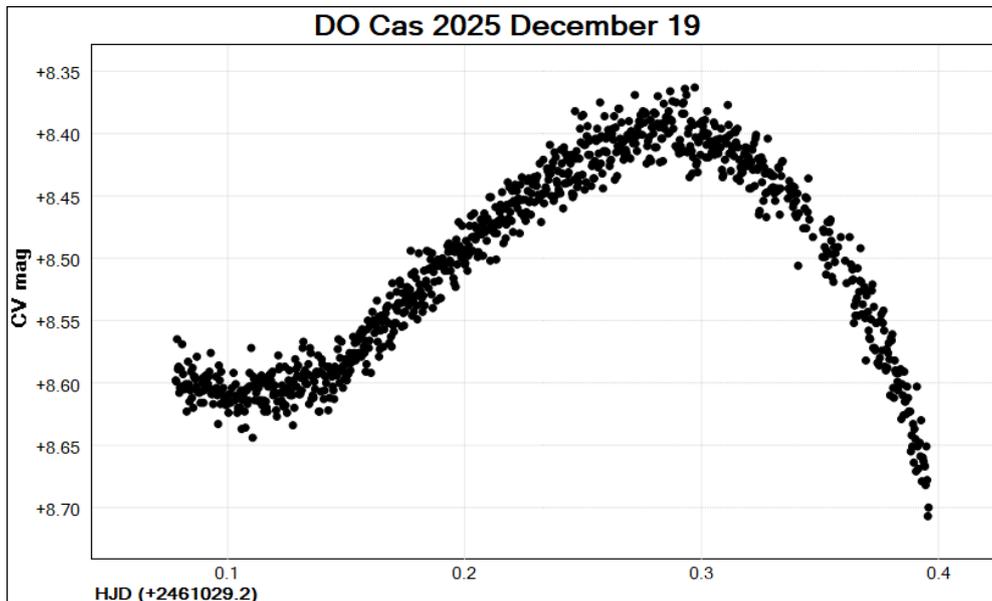
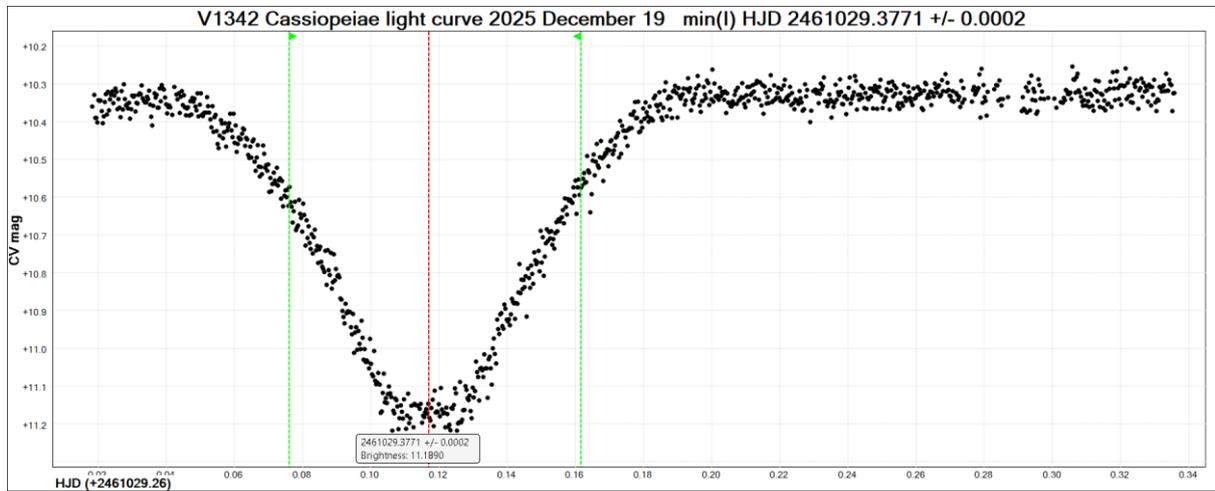
There is currently no way to disable dithering in the supplied app, but there are free programs available online, such as *alpaca*, which runs in Windows, which will allow dithering to be disabled, as well as adjusting other parameters such as exposure times and focus more freely. (Online discussion groups also mention NINA and ASCOM, which I have not used.) My experience of *alpaca* is mixed. It takes a while to input all the required parameters, and I have used it successfully, but sometimes it just gets stuck in a loop due to my current lack of experience. Restarting and redoing this can take longer than using manual tracking mode.

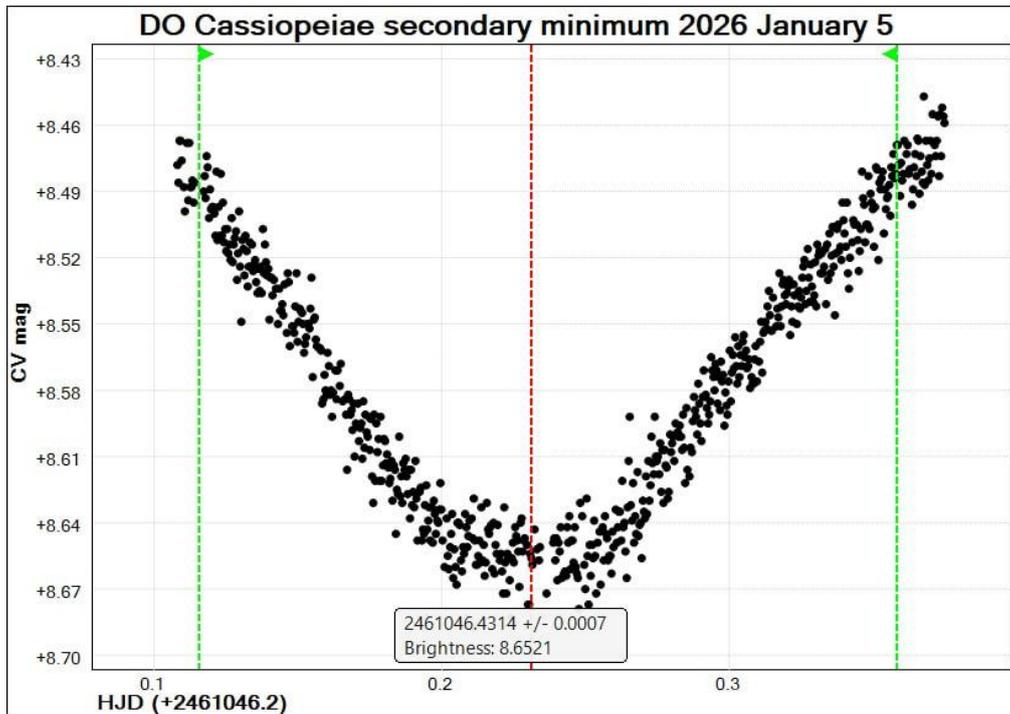
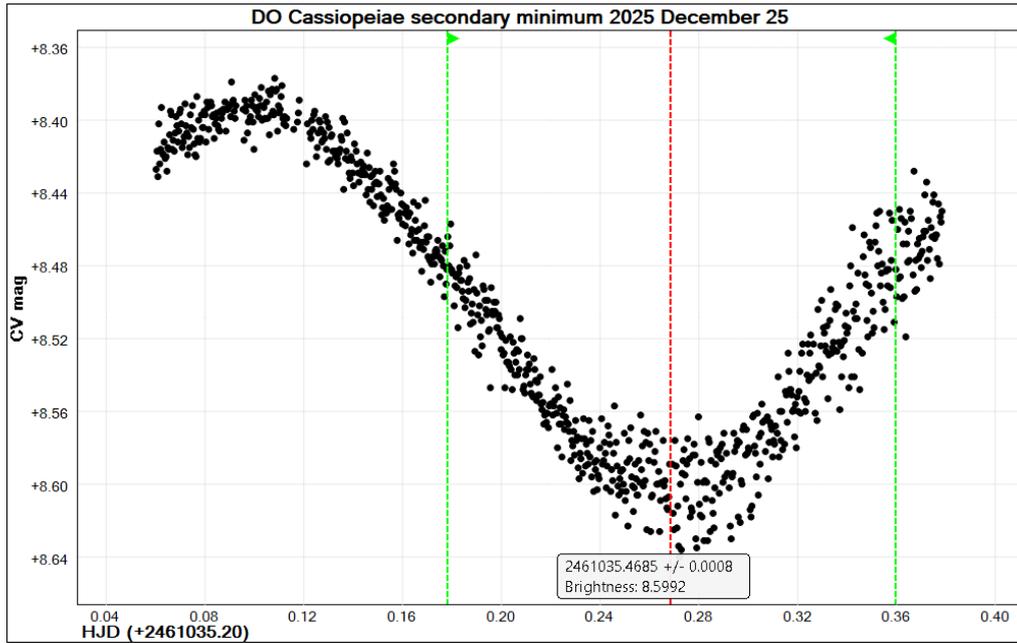
A possible software incompatibility issue is with the AIP4WIN header for the S30 images which gives a BITPIX value of 16 (i.e. 16 bits per pixel) and a corresponding PV max value of 65535, while the *Starlight-grade Sony IMX662* CMOS chip used is 10/12 bit. This can also appear in the PV max values in AIP4WIN Star Image Tool. This was not responsible for the constant maximum value of V1342 Cas below; the 2 mag brighter DO Cas was in the same images and photometry did not appear to be affected by this. More investigation needed.

There are several online discussions regarding possible software issues with the official Seestar app and other relevant apps, including with their updates. As ever, some comments are more useful than others.

The weather has not been great for the past few weeks, but towards the end of December and early January I obtained the following minima; a primary minimum of V1342 Cas on December 19, and secondary minima of DO Cas on December 25 and January 5. The next experiment will be to observe the same eclipse with both the S30 and the 2" Titan to compare and contrast their results.

To conclude, this has been a useful exercise demonstrating that the S30 smart telescope can, with a few tweaks, produce useful results observing variable stars. Other smart telescopes are available and, just to reiterate, this is neither an objective review nor a definitive 'how to' article!





Observations of times of minima of the above eclipsing binaries were made in December 2025 and January 2026 with a Seestar [S30](#) at Somerby Observatory. Photometry of the images was performed in AIP4WIN, and light curves and times of minima were determined using Peranso.

STAR	HJD of minimum	Filter	Error +/-	Type of minimum
V1342 Cas	2461029.3771	CV	0.0002	Primary
DO Cas	2461035.4685	CV	0.0008	Secondary
DO Cas	2461046.4313	CV	0.0007	Secondary

## Section Publications

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Charts for all stars on the BAAVSS observing programmes are freely available to download from the VSS Website [www.britastro.org/vss](http://www.britastro.org/vss)

## Contributing to the VSS Circular

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Written articles on any aspect of variable star research, observing or letters are welcomed for publication in these *circulars*. The article must be your own work and should not have appeared in any other publication. Acknowledgement for light curves, images and extracts of text must be included in your submission if they are not your own work! References should be applied where necessary. Authors are asked to include a short abstract of their work when submitting to these *circulars*.

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

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

Email addresses will be included in each article unless the author specifically requests otherwise.

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

**Deadline for the next VSSC is May 15<sup>th</sup> 2026**

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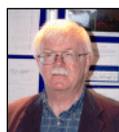
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