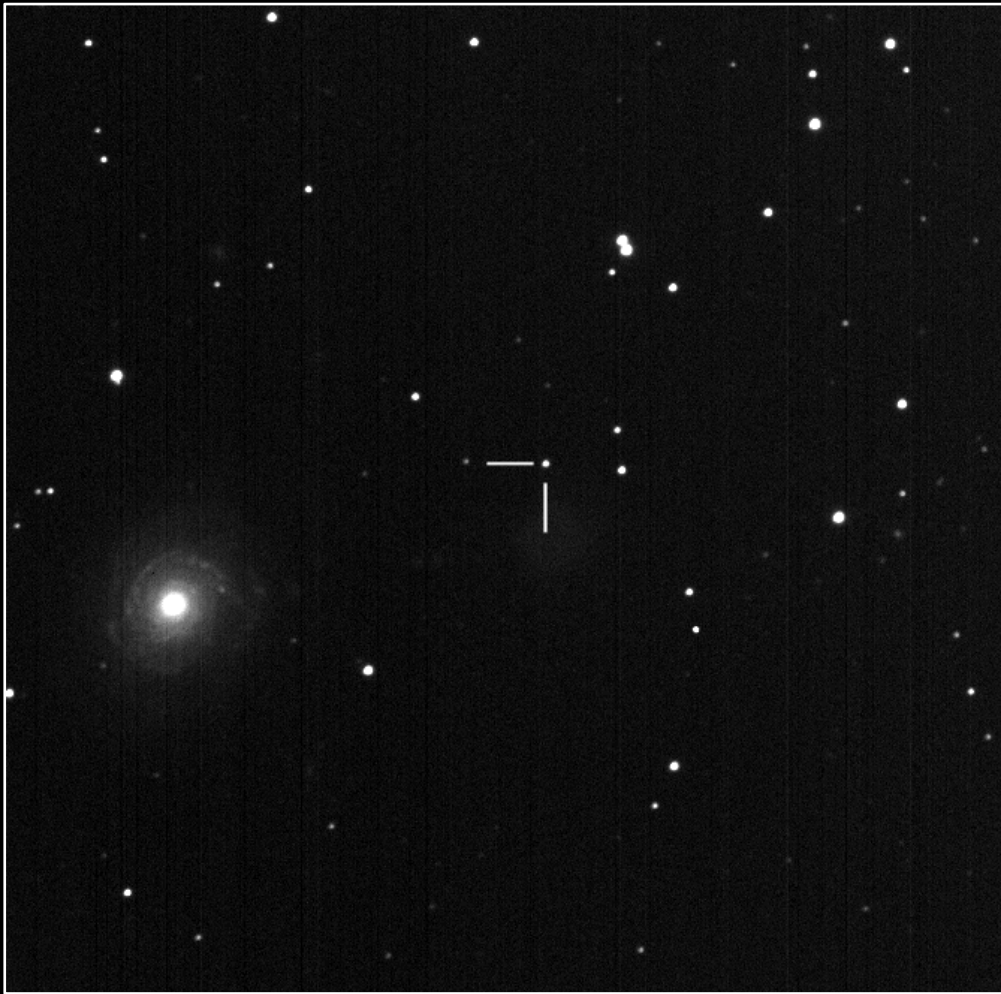


ISSN 2631-4843

The British Astronomical Association

# Variable Star Section Circular

No. 208 June 2026



BAA Office: PO Box 702, Tonbridge TN9 9TX

# Contents

From the Director .....	<a href="#">3</a>
Identifying charts and comparison stars in our database. <i>Andrew Wilson</i> .....	<a href="#">5</a>
CV & E News. <i>Gary Poyner</i> .....	<a href="#">6</a>
Cataclysmic Variables – Still behaving badly. <i>David Boyd</i> .....	<a href="#">10</a>
Is IX Dra a period bouncer? <i>Stewart Bean</i> .....	<a href="#">13</a>
HD 89192 in Vela is an $\alpha^2$ Canum Venaticorum Variable. <i>John Greaves</i> .....	<a href="#">17</a>
NSV 4031 is a gamma Doradus variable after all. <i>Christopher Lloyd</i> .....	<a href="#">18</a>
A DIY Dual Beam Polarimeter. <i>John Simpson</i> .....	<a href="#">24</a>
Some Memories of Peter Francis Williams. <i>John Toone</i> .....	<a href="#">32</a>
Eclipsing Binary News. <i>Des Loughney</i> .....	<a href="#">38</a>
More Observations of Variable Stars Using a Smart Telescope. <i>David Conner</i> .....	<a href="#">41</a>
AP Leonis is an Algol Type Eclipsing Binary with synchronous RS Canum Venaticorum Light-curve Modification Superposed. <i>John Greaves</i> .....	<a href="#">45</a>
Section Publications & Contributing to the VSSC .....	<a href="#">47</a>
Section Officers.....	<a href="#">48</a>

## Cover Picture

Outburst of the UGSU star CP Dra & NGC 3147  
2026, May 21.917UT 15.29CV

50 second exposure. CDK 17, Slooh Canary 2

Gary Poyner

## From the Director – *Jeremy Shears*

---

It was good to hear from many people that they enjoyed clear skies in the second half of April, though I'm sure there were a few complaints about the resulting lack of sleep. Here in Cheshire, I was able to observe on nine consecutive nights. There was then a cloudy night followed by a further two clear ones. May had other ideas....

I was lucky because this clear spell coincided with my return for my month-long 'Great Southwestern Retirement Road Trip': 2000+ miles across Arizona and Southern California. Naturally, I visited a few observatories along the way: Kitt Peak, Lowell, and Mount Palomar. The highlight was observing through the 24-inch Clark at Lowell. I also spent a very enjoyable afternoon hosted by Brian Skiff, who works at the observatory. He has a broad range of research interests including variable stars. We talked about his various research projects.



Brian Skiff with the refractor used by A.E. Douglass to test potential sites for observatories in the US Southwest and Mexico (Percival Lowell's car is in the background)

### Observing campaigns

Just a reminder of the request for observations of **ZZ Psc** (see the September [2025 Circular](#)) by Tim Cunningham of the Center for Astrophysics at Harvard in support of his ongoing JWST observing campaign. Tim's next JWST observing window is scheduled for 2026 Jul 25 – Aug 3. Although perhaps not the best time for Pisces, his top priority is for amateur observers to obtain ground-based

photometry within this window. A week either side of that is the next highest priority. Beyond that, any long-baseline observations taken this year will also be extremely valuable.

Mark Kidger is also keen to receive observations of **OJ 287**. It has been brightening of late; my recent observations have had it around mag 14.7 CV. I lost it behind my local horizon in mid-May. It will be important to recommence observations as soon as possible after solar conjunction.

The campaign to detect outbursts and superoutbursts of ER UMa stars coordinated by Stewart Bean continues. Targets are **IX Dra**, **ER UMa**, **RZ LMi** and **V1159 Ori** (The latter now lost to view but see Stewart's article about its behaviour in the [March VSSC](#) – Stewart discusses IX Dra later in this *Circular*.

And, of course, we have a good view of **T CrB** for the next months. Speculations about an imminent outburst appear from time to time (e.g. [ATel 17784](#)), but no one really knows.

### **V623 Cam**

As a variable star observer, one sometimes has to wait a while until one sees a significant change in some stars. That's part of the enjoyment: will the star have changed when I go out to observe tonight? Of course, it helps to have a broad portfolio of stars, with a range of behaviours, to keep the interest going.

One star I have been following for the past 20 years, **V623 Cam**, is a case in point. It is undergoing a deep low state at the time of writing.

**V623 Cam** is a Nova-like variable that spends most of its time at magnitude ~14.8 V. In 2024 Feb it began a fade to 18<sup>th</sup> mag but recovered by the end of 2024 August. A new fade began in 2025 March, this time to around 19<sup>th</sup> mag, where it remains. This behaviour supports the idea that it is a VY Scl star.

It's worth keep an eye on it to see how long this low state lasts. Its high declination means it is circumpolar from the British Isles (RA 05 13 36.57, Dec +77 28 42.8 [J2000.0]). **V623 Cam** is also known by its Hamburg Quasar Survey name, HS 0506+7725. Its  $P_{\text{orb}}$  is 0.1477 d = 3.54 h ([VSX](#)).

I see my first observation of V623 Cam was on 2006 April 22. I wonder how it will be faring in another 20 years. And me!

### **Valete**

The global variable star community received the sad news that **Peter Williams** passed away on 3 March. Peter was a great visual observer. Do have a look at [VSSC 189](#) for Peter's reflections on 50 years of observing variable stars. John Toone writes further about Peter in this *Circular*.

We also lost **Colin Munford** who passed away peacefully on 24 March 2026, aged 93 years. Colin was a consistent and reliable observer, with 14,220 visual estimates made between 1953 and 1985 listed in the VSS photometry database. Colin served as VSS Secretary for five years from 1962. He received the Association's Steavenson Award for his observational work on variable stars and for his service to the VSS in 1980. A full obituary of Colin, written by Richard McKim and myself, will appear in a future *BAA Journal*.

## Identifying charts and comparison stars in our observations

Andrew Wilson

[andyjwilson\\_uk@hotmail.com](mailto:andyjwilson_uk@hotmail.com)

---

***At the 2026 BAA Winchester Weekend I had a discussion about how charts/sequences and comparison stars are reported to the VSS Photometry Database. This is working well, though it was pointed out that we could provide more guidance. That is the purpose of this short note.***

The guiding principle is the information provided should be sufficient to identify both the comparison stars, and the chart or photometric survey that provided the comparison star magnitudes. This is to help researchers to understand all the potential sources of difference between observations, and in the case of visual observations this enables a future recalculation of the estimate if the sequence is updated. It is also advisable to use the latest chart and to periodically check for new charts. Comparison stars may have been removed if they were discovered to be variable, or their colour led to discrepancies in the reported magnitudes.

The reporting of charts and comparison stars is relatively straightforward for visual observers. When using a BAA VSS chart you enter the chart id, for example the latest chart for Z UMa would be entered as “VSS 217.02” or simply “217.02”. The comparison stars are included in the in the visual estimate, for example “H(1)V(1)L” using the fractional method. For an AAVSO chart you quote their chart id and comparison star ids.

This is a little more complicated for digital observers due to the variety of comparison star photometry sources and processing software. Most observers use either AAVSO charts or an ensemble of photometry from a survey like Gaia DR3 G-band transformed to V-band magnitudes. Those using AAVSO charts should report the chart id as “X23789TG” or even better “AAVSO X23789TG”. The ideal way to report AAVSO comparison stars is using their AUID (e.g. “000-BLB-681” or “AUID 000-BLB-681”). Otherwise use the id reported on the chart or photometric table, like “126”. Though care is required as there can be instances of more than one star with the same numeric id, in which case report “126 North” or similar.

When it comes to reporting bespoke charts/sequences, please ensure you give the source of the photometry (e.g. Gaia DR3, APASS DR10), and use the comment field if you need to add extra information. If you use a large ensemble of comparison stars where it is not feasible to report them all, then something like “Ensemble of comparison stars” should be entered in the comment field.

## CV & E News

Gary Poyner

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

---

***We report details of the unusual outburst behaviour in the dwarf nova X Leo during Spring 2026, a minor rebrightening of the UGSU star QZ Vir following a March 2026 superoutburst, and announcement details of the possible recurrent nova in Aql – AT2026lck.***

### **X Leo – unusual outburst behaviour**

X Leo is a UGSS type dwarf nova, with an outburst period of around 17 days and a catalogue amplitude of 11.8 to 17.2V ([VSX](#)). It was discovered in 1906 by J. Metcalf and has been under constant observation by the AAVSO since 1920, with the BAAVSS coming in much later at March 1972. Since that time, the VSS has accumulated over 12,000 observations from 88 observers. Lying on the ecliptic, we have a disrupted observing season which lasts from October through to May, and monthly interventions by the Moon.

From a visual inspection of the VSS light curve since 1972, there are two types of outburst – long and short. The longer generally being brighter by just under a magnitude and 3-5 days longer at maximum. For a more in-depth work on the outbursts of X Leo during the 1970's, see reference 1.

It's never easy to determine which, if any, outbursts are anomalous by nature, but again a visual inspection of the VSS light curve does not show anything which might stand out as abnormal in the VSS data – until quite recently.

Early March saw a normal outburst on the 4<sup>th</sup> at 12.7mv, fading to 15.0mv by the 14<sup>th</sup>. Five days later (March 19), X Leo had risen to magnitude 14.2mv and peaked at 13.1mv on the 20<sup>th</sup>, fading to 14.7mv four days later on the 24<sup>th</sup>. One day later X Leo had risen again to magnitude 13.6mv. We then have a gap because of weather and the passing through of the Moon until we see X Leo at 15.9V on April 5<sup>th</sup>. From the 5<sup>th</sup>, we now see a long outburst taking seven days to maximum brightness of 12.2, remaining at maximum for six days before fading to 15.4mv over a further six days to April 23<sup>rd</sup>. Just three days later on the April 28<sup>th</sup>, X Leo was again bright at magnitude 14.2mv, rising to a maximum of 12.73V over five days by May 3. Just eight days later, X Leo was again detected at 15.3V on May 11, rising to 12.3mv four days later on May 15<sup>th</sup>. Just three days later X Leo had faded to 13.9V by May 18 and eventually 15.6V and CV by May 21<sup>st</sup>. The near FQ Moon passed through on May 22<sup>nd</sup> and 23<sup>rd</sup>, and a V-band observation of May 25.9 at 13.78V showed X Leo to be in outburst once again – the seventh outburst in just 83 days, rising to 12.22C four days later (Fig. 1).

This has been an interesting three months observing X Leo, normally a most reliable outbursting dwarf nova. Observations should be possible from late October, so perhaps a more concerted effort should be made to pick up the field in the morning sky to continue to monitor for any unusual behaviour which may be present.

The VSS thanks all observers of X Leo who observe and report their observations to the database, and especially the following observers whose observations contributed to figure 1....

L K Brundle, G Fleming, G Poyner, I Sharp, J Toone, T Vale & I L Walton

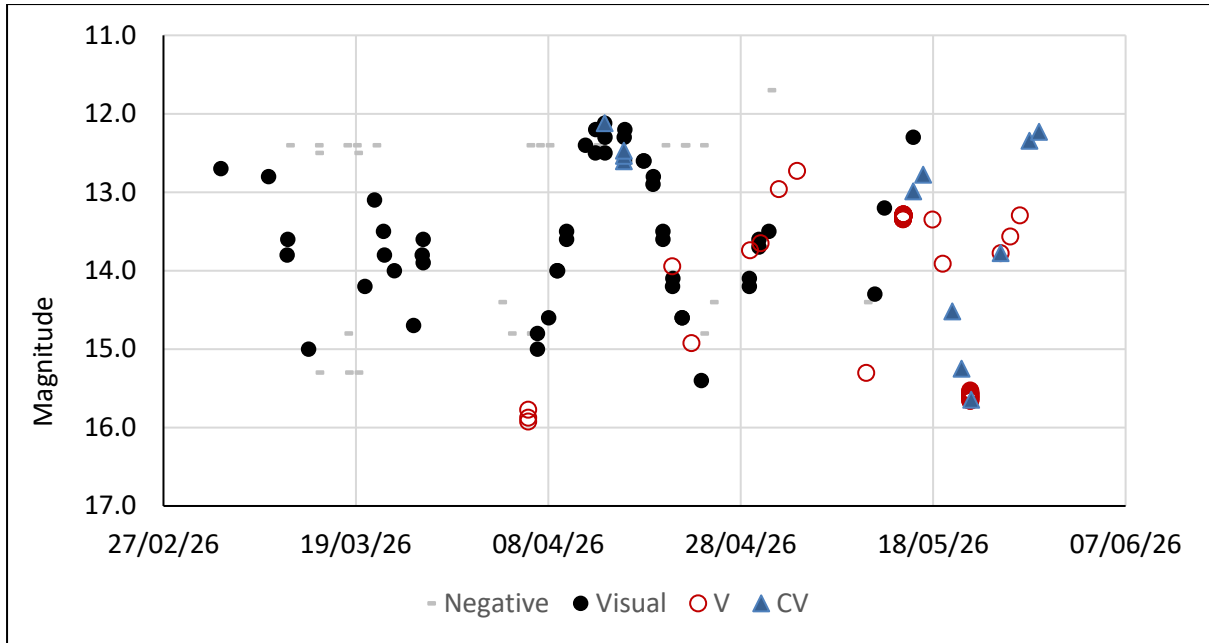


Figure 1: Unusual outburst behaviour of X Leo during March to May, 2026. *BAAVSS Database*.

### QZ Vir

Once known as T Leo (until the designation was updated in 2006 to QZ Vir because of erroneous coordinates or changes to constellation boundaries [2] and included in the 78<sup>th</sup> Name List of Variable Stars [3]), this dwarf nova is somewhat an under observed object by the VSS, with just over 3,800 observations made by thirteen observers since 1991. Classed as a UGSU star, pre and post outburst brightenings are rare in this object, unlike other well established UGSU stars (UV Per for example).

However following a fairly well covered Superoutburst in the first week of March, QZ Vir returned to quiescence 61 days after maximum at magnitude 16.25V. Six days later, it increased in brightness by 0.8 magnitudes, and by the 17<sup>th</sup> May peaked at 15.1CV, and four days later returning to quiescence at 16.0V (figure 2) a very shallow rebrightening! Ian Sharp recorded short duration variation on May 19-21, which was reported to BAAVSS-Alert. Two of those runs are produced below (Figure 3).

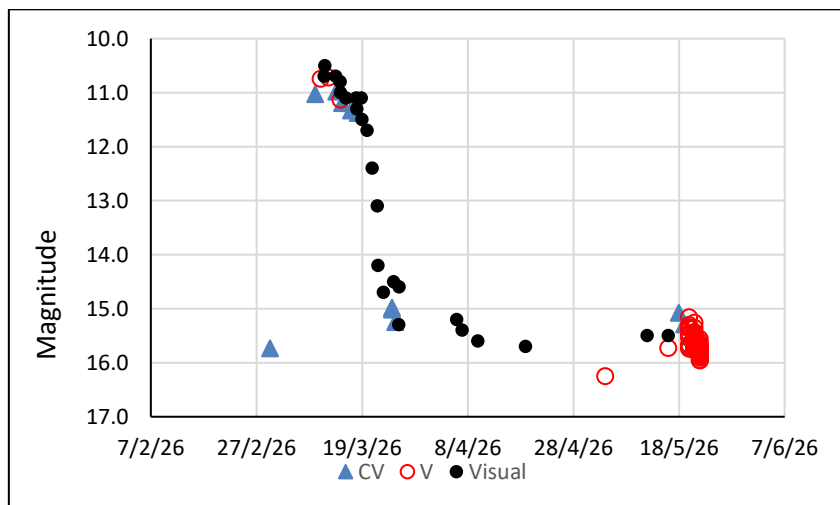


Figure 2. QZ Vir, March 2026 Superoutburst. G Poyner, I Sharp, J Toone, I L Walton. *BAAVSS Database*

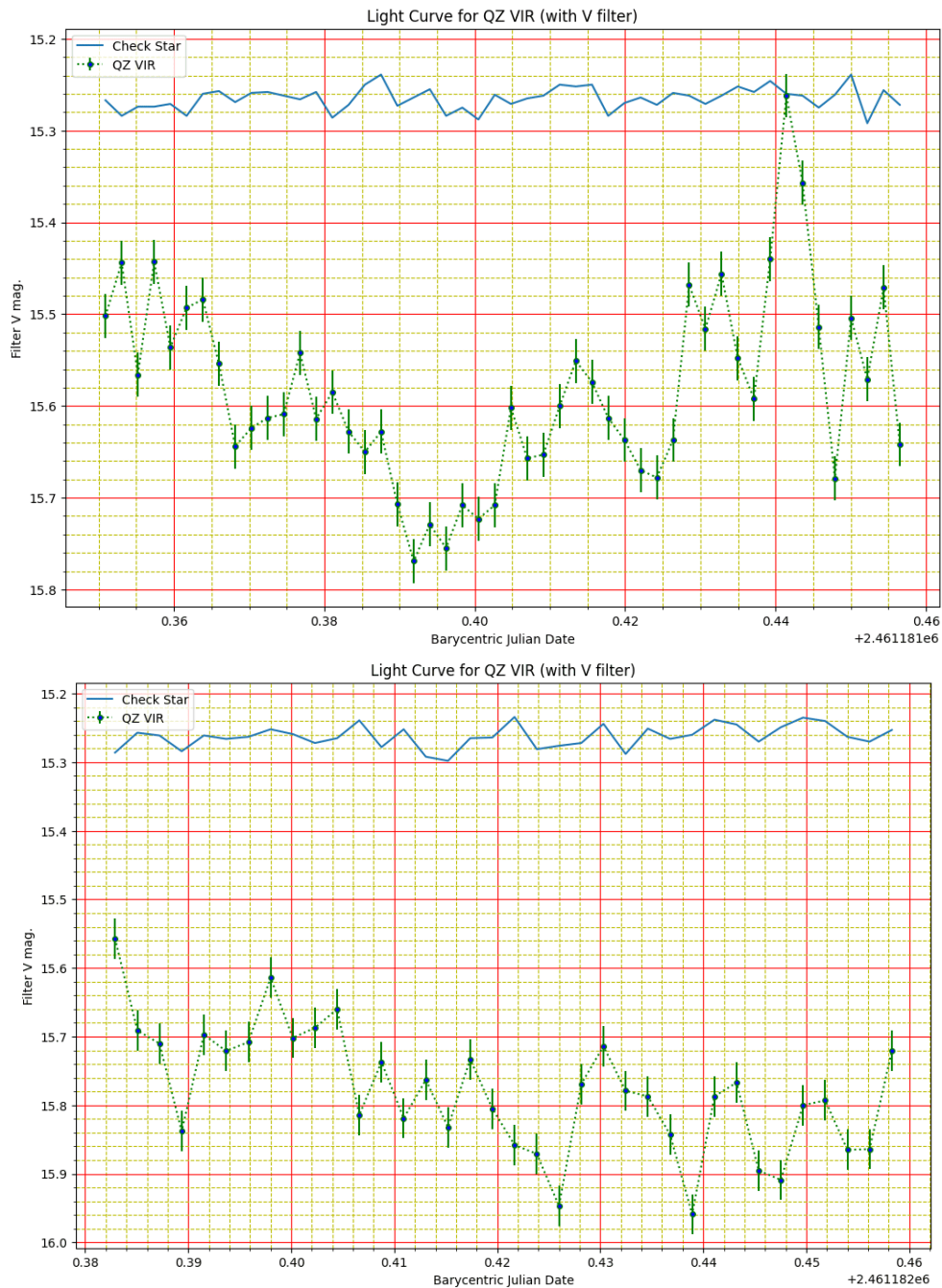


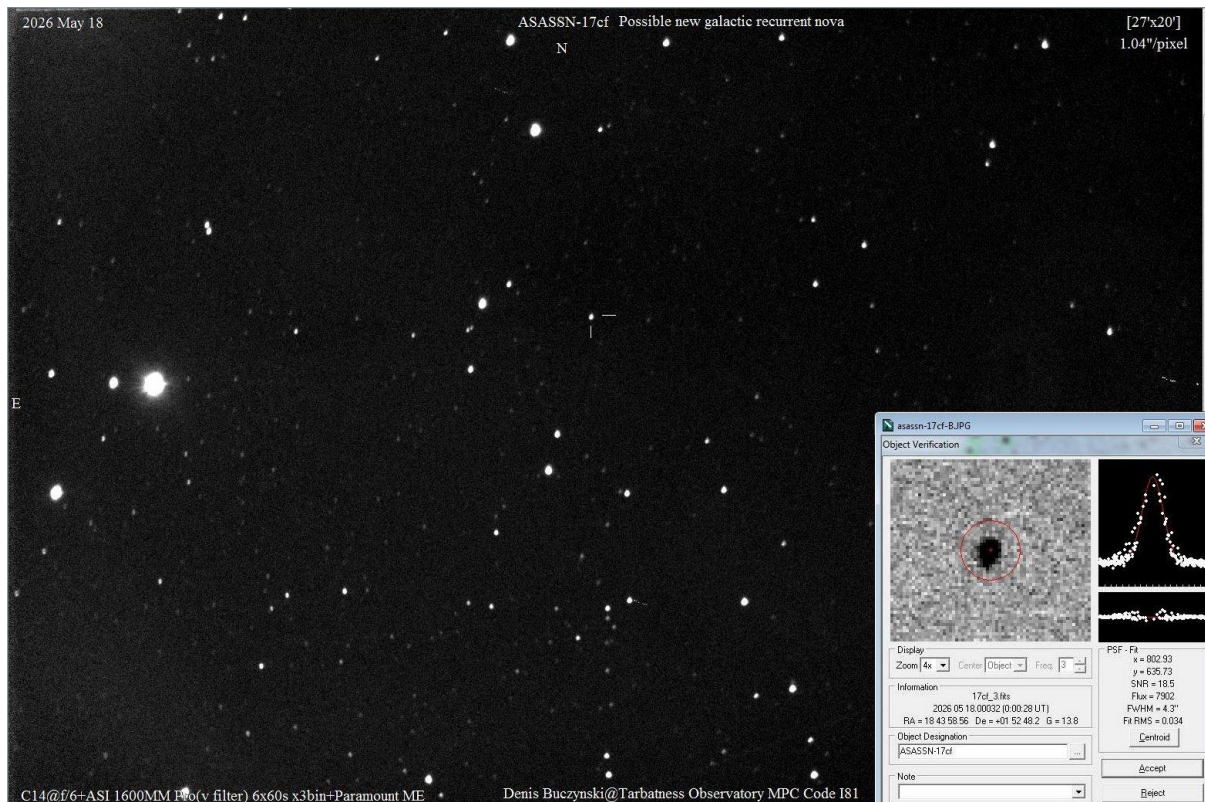
Figure 3. Two V-band CCD runs on QZ Vir – Top May 20 22h 19m to May 21 00h 51m (50 images), and bottom May 21 23h 05m to May 22 00h 54m (36 images). Ian Sharp. PixelSkies, Spain with C11 at F/7 using a Moravian C3-26000 PRO CMOS Camera.

### AT2026lck (ASASSN-17cf) - A new Galactic Recurrent Nova?

A possible new Galactic Recurrent Nova in Aquila has been reported, with outburst detections in 2010, 2017 and 2026. The r-mag amplitude is around 7 magnitudes. This will bring the number of galactic recurrent novae up to eleven if confirmed. Further details can be seen in ATel [17801](#).

Robin Leadbeater has obtained a spectrum, which can be seen with explanatory text on the BAA website gallery [here](#).

Denis Buczynski obtained an image on May 18 with his C14 from his Tarbatness observatory (see below). Denis measured the magnitude at 13.8G using Astrometrica.



## Reference

- 1: X Leonis, 1970-1979. Doug Saw, JBAA, [Vol. 92, No.5, p220-226](#)
- 2: N. N. Samus et al., 2006, Astronomy Letters, 32, 263, section "The Variables to be Renamed"
- 3: Kazarovets et al, [IBVS 5721](#), August 8, 2006

# Cataclysmic Variables – Still behaving badly

David Boyd

[davidboyd@orion.me.uk](mailto:davidboyd@orion.me.uk)

---

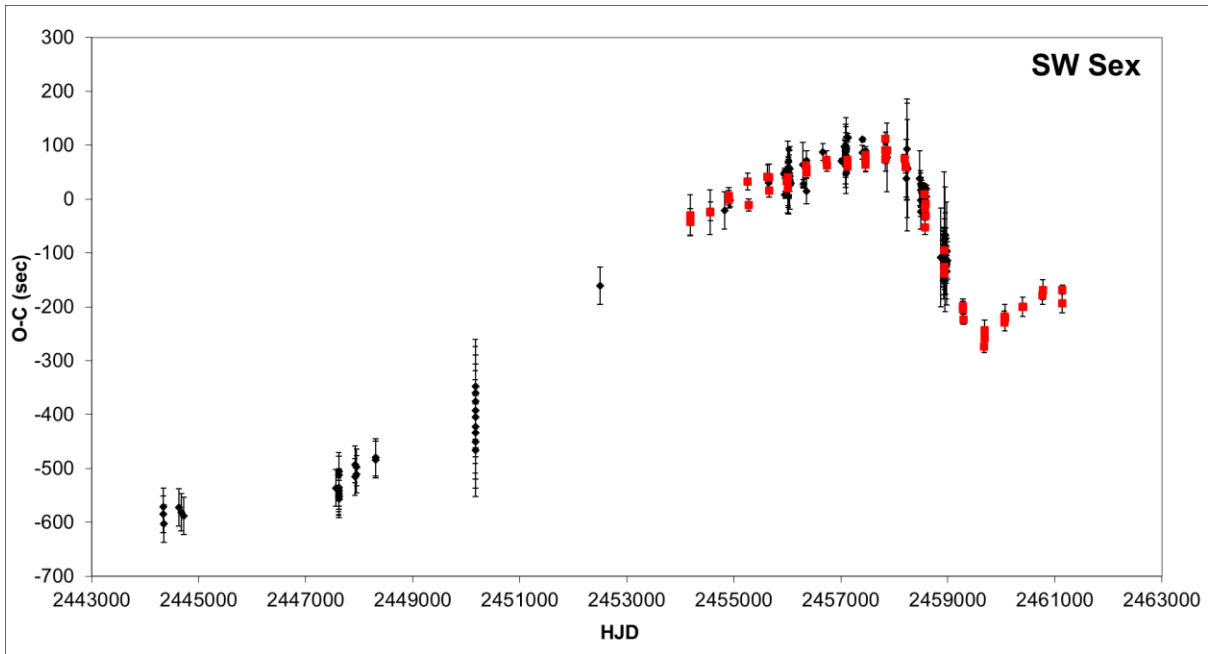
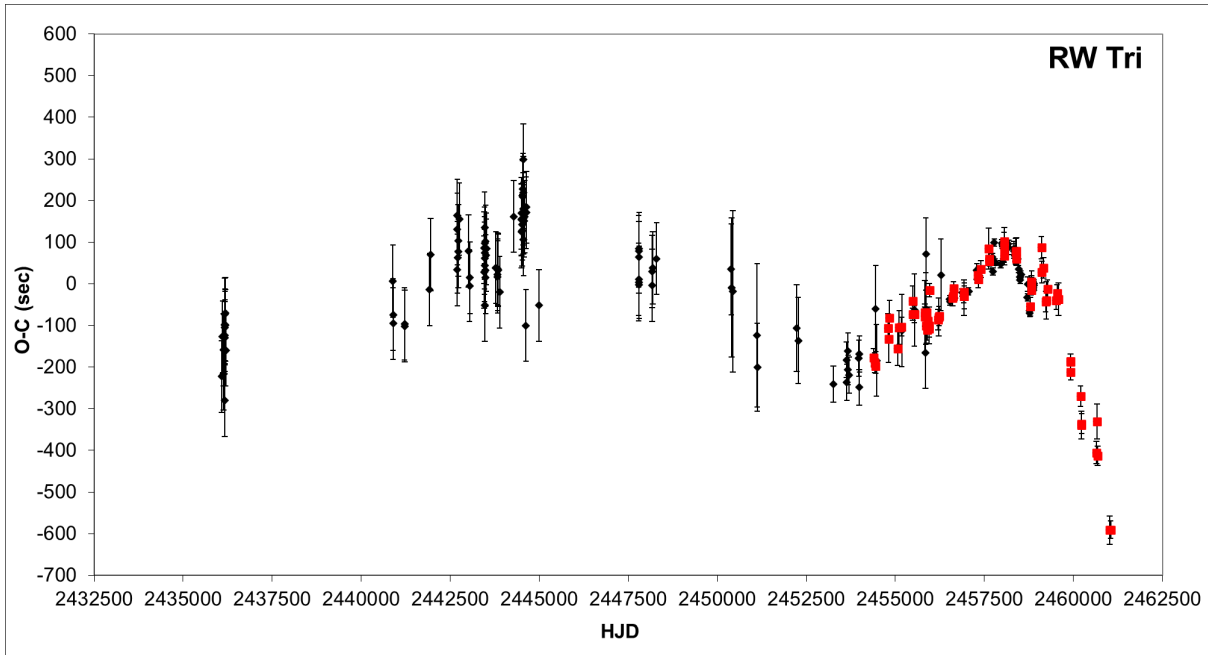
***We report on recent eclipse timing measurements of the eclipsing nova-like CVs RW Tri, SW Sex, AC Cnc and DW UMa which continue to show behaviour not explicable by the standard model of CV evolution.***

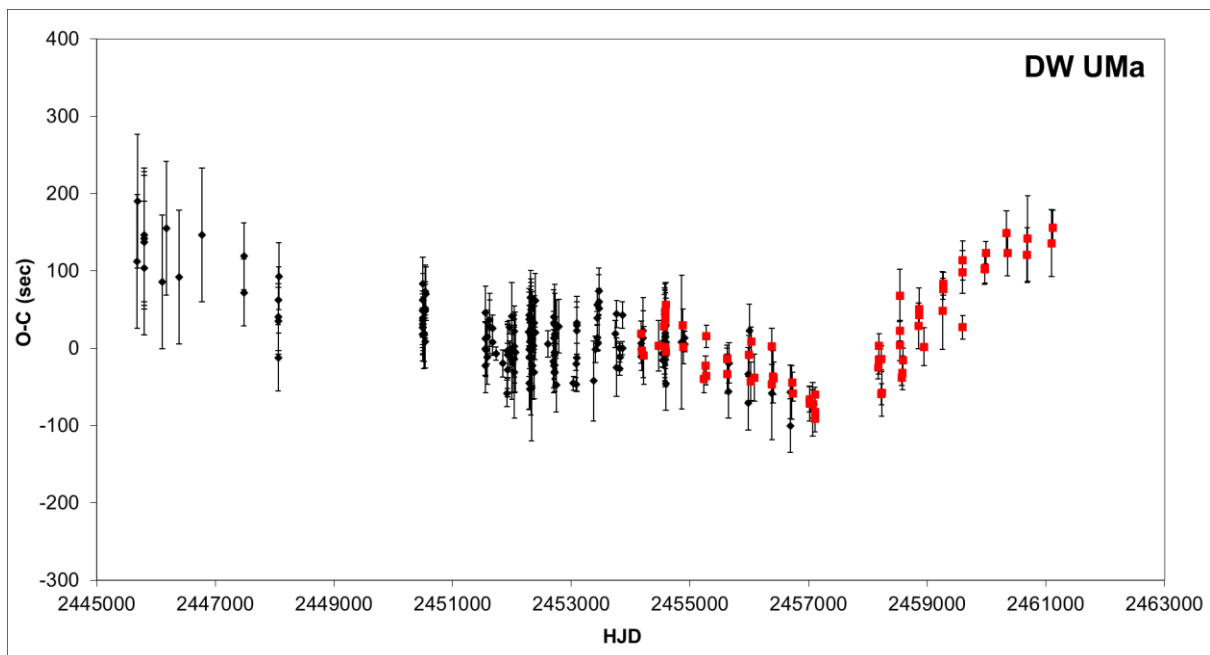
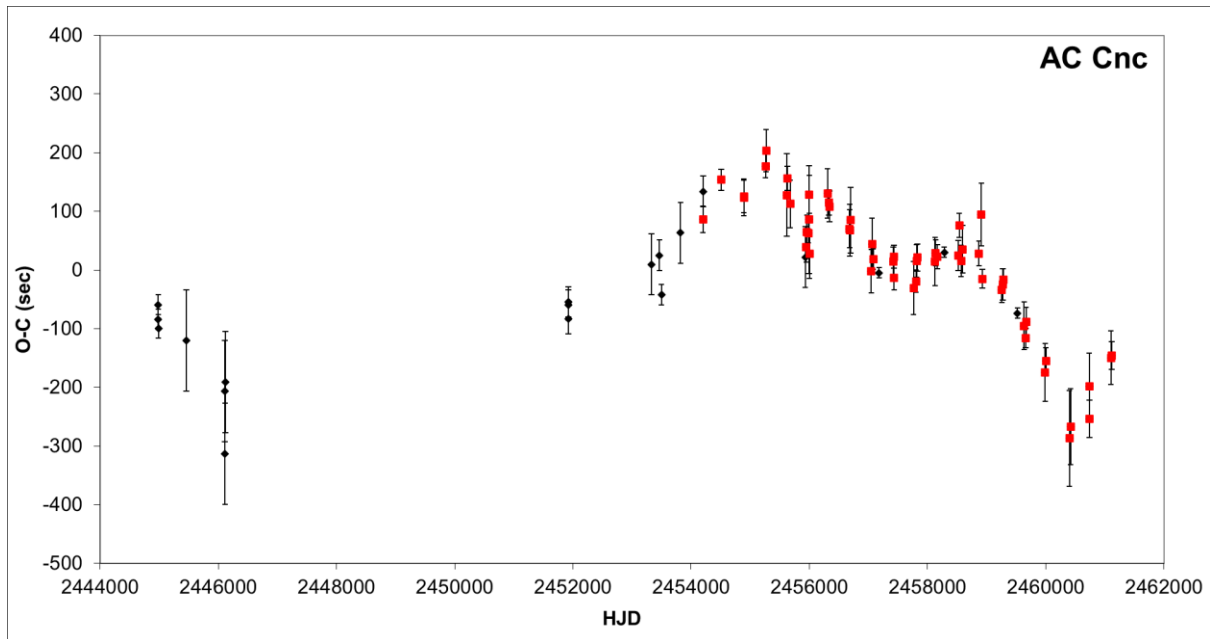
## **Background**

Nova-like cataclysmic variables (CVs) are relatively bright and maintain a high rate of transfer of hydrogen-rich material from a main sequence secondary star to a white dwarf primary via Roche lobe overflow. This maintains the accretion disc around the primary in a bright state and inhibits the disc instability mechanism responsible for dwarf nova outbursts. The orbital period of these systems might be expected to evolve steadily over many years according to various possible mechanisms including mass transfer, angular momentum loss through magnetic braking or gravitational radiation and stellar magnetic reorganisation. A long-term study of 18 eclipsing nova-like CVs (Boyd 2023) showed that while many of them do indeed show such long-term trends, some do not. RW Tri, SW Sex, AC Cnc and DW UMa were particularly notable as having behaviour which could not be explained in terms of any of the conventional CV evolution mechanisms. Similar apparently erratic orbital behaviour has recently been reported in other CVs which cannot be explained in terms of proposed explanations including multiple circumbinary bodies (Pulley et al. 2025).

## **Observations**

As part of an on-going project to monitor these stars, an updated linear eclipse ephemeris was computed for each star and the O-C (observed minus calculated) times for each eclipse were used to form an O-C diagram. A linear trend in an O-C diagram indicates a constant orbital period while O-C trajectories curving upward indicate an increasing period and curving downward a decreasing period. In the following plots eclipse timings published in the literature are shown in black while those measured by the author are in red.





## References

Boyd D., Journal of the AAVSO, 51, 74 (2023)

[https://apps.aavso.org/media/jaavso/3882\\_qKgpeOe.pdf](https://apps.aavso.org/media/jaavso/3882_qKgpeOe.pdf)

Pulley D. et al., Monthly Notices of the Royal Astronomical Society, 544, 24 (2025)

<https://academic.oup.com/mnras/article/544/1/24/8268884>

# Is IX Dra a period bouncer?

Stewart Bean

[sjbeanmail@aol.com](mailto:sjbeanmail@aol.com)

---

***Period bouncers are dwarf novae that have evolved through the period minimum to remerge with increasing orbital periods. This note re-examines the orbital period of IX Dra and confirms that IX Dra is a DN that has yet to approach the period gap.***

## 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 and viscosity oscillations in the accretion disc which in turn produce a series of brightening events known as normal outbursts. When the disc radius grows to about  $r=0.46$  of the binary separation (Knigge, C. et al), the disc becomes unstable and a long duration superoutburst, brighter than normal outbursts, returns the disc to its initial state. The sequence of normal outbursts followed by a superoutburst then repeats.

## Evolution of Dwarf novae

Theory suggests these systems evolve as their orbital periods shorten due to the loss of angular momentum. Eventually, they reach a "period minimum" of roughly 90 minutes before their orbital periods begin to increase again. Systems that have passed this minimum orbital period and have increasing orbital periods are known as period bouncers.

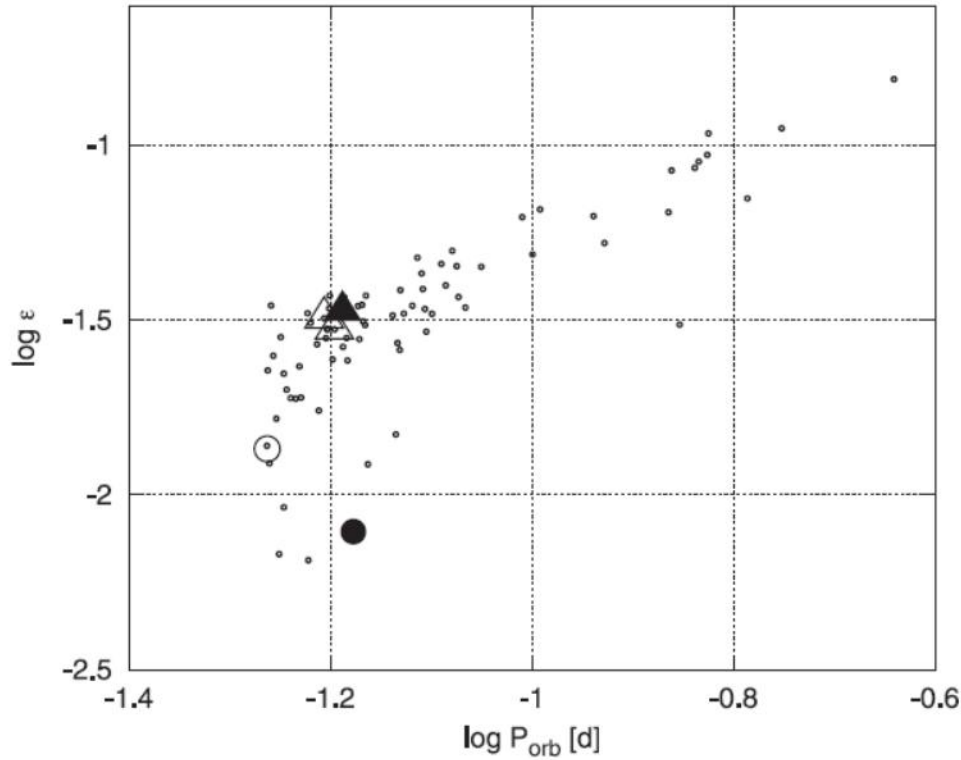
This note places IX Dra with ER UMa and V1159 Ori, as DNe whose orbital periods are getting shorter and are yet to approach the period minimum.

## Literature review

Identifying the evolutionary status of IX Dra has been difficult because its orbital period ( $P_{orb}$ ) is hard to measure. Without an accurate  $P_{orb}$  researchers could not accurately calculate the period excess ( $\epsilon$ ), which is the difference between the superhump period  $P_{sh}$  and the orbital period  $P_{orb}$ . Consequently, it was unclear if IX Dra was a period bouncer or still approaching the period minimum.

IX Dra has been studied by Olech, A. et al and Otulakowska-Hypka, M et al. Fig 15 from Otulakowska-Hypka, M is reproduced below to illustrate the evolutionary path of a collection of DNe stars in a plot of period excess against orbital period.

Stars move from top right leftwards until they reach a period minimum of only about 90 minutes. They then move down the graph towards the bottom right as so-called period bouncers. DNe examples are indicated: ER UMa and V1159 Ori (open triangles), DI UMa (open circle), and IX Dra (both a filled circle and a filled triangle). IX Dra has two locations owing to two possible values for  $P_{orb}$  leaving the possible interpretation that IX Dra could be a period bouncer.



**Figure 15.** The relation between the orbital period–superhump period excess and the orbital period for dwarf nova stars. The small points represent known objects, from Olech et al. (2011). The black dot corresponds to the position of IX Dra obtained from  $P_{orb}$  and  $P_{sh}$ . The black triangle indicates the position of IX Dra calculated from  $P_{f4}$  and  $P_{sh}$ . The open symbols show positions of other ER UMa-type objects: triangles stand for ER UMa and V1159 Ori, and the circle for DI UMa.

Figure 1. Evolutionary plot taken from Otulakowska-Hypka, M. showing two possible locations for IX Dra owing to uncertainty in the orbital period. The solid circle position, if correct, is associated with a period bouncer.

To place a star on this plot we need both the orbital period ( $P_{orb}$ ), and the period excess ( $\epsilon$ ).

The period excess ( $\epsilon$ ) is:

$$\epsilon = \frac{\Delta P}{P_{orb}} = \frac{P_{sh} - P_{orb}}{P_{orb}}$$

Where  $P_{sh}$  is the superhump period.

The period excess  $\epsilon$  sensitively depends upon the difference between the superhump period,  $P_{sh}$ , and the orbital period  $P_{orb}$ . With  $P_{orb}$  being uncertain, the location of IX Dra on the evolutionary plot becomes uncertain.

## Determining the orbital period for IX Dra.

The orbital period can be found from either Doppler shifted wavelength variations in either emission or absorption lines or period analysis of a light curve. Recently, Thorstensen, J.R. included IX Dra in a collection of thirty stars whose orbital period was determined by spectroscopy. IX Dra proved a challenge as it is usually in an active state. However, they finally obtained one good experimental run and determined a value of 0.06480(16) d.

The second method is to take a light curve and apply period analysis. This has been possible recently using light curves from the TESS space telescope (NASA). Both Sector 19 and 26 provide quality data over about 25 days containing only normal outbursts. My analysis, using the built-in tools in Lightkurve give the period as 0.06482 d for Sector 19 and 0.06479 d for Sector 26. Attempts to determine a period from one- or two-day sections of the light curve proved unsuccessful. A period of 0.0648 d is taken as a good estimate of the orbital period and is in good agreement with the spectroscopy-based period from Thorstensen, J.R.

The IX Dra light curve from TESS Sector 26 data, and the period analysis, is presented below in Figure 2.

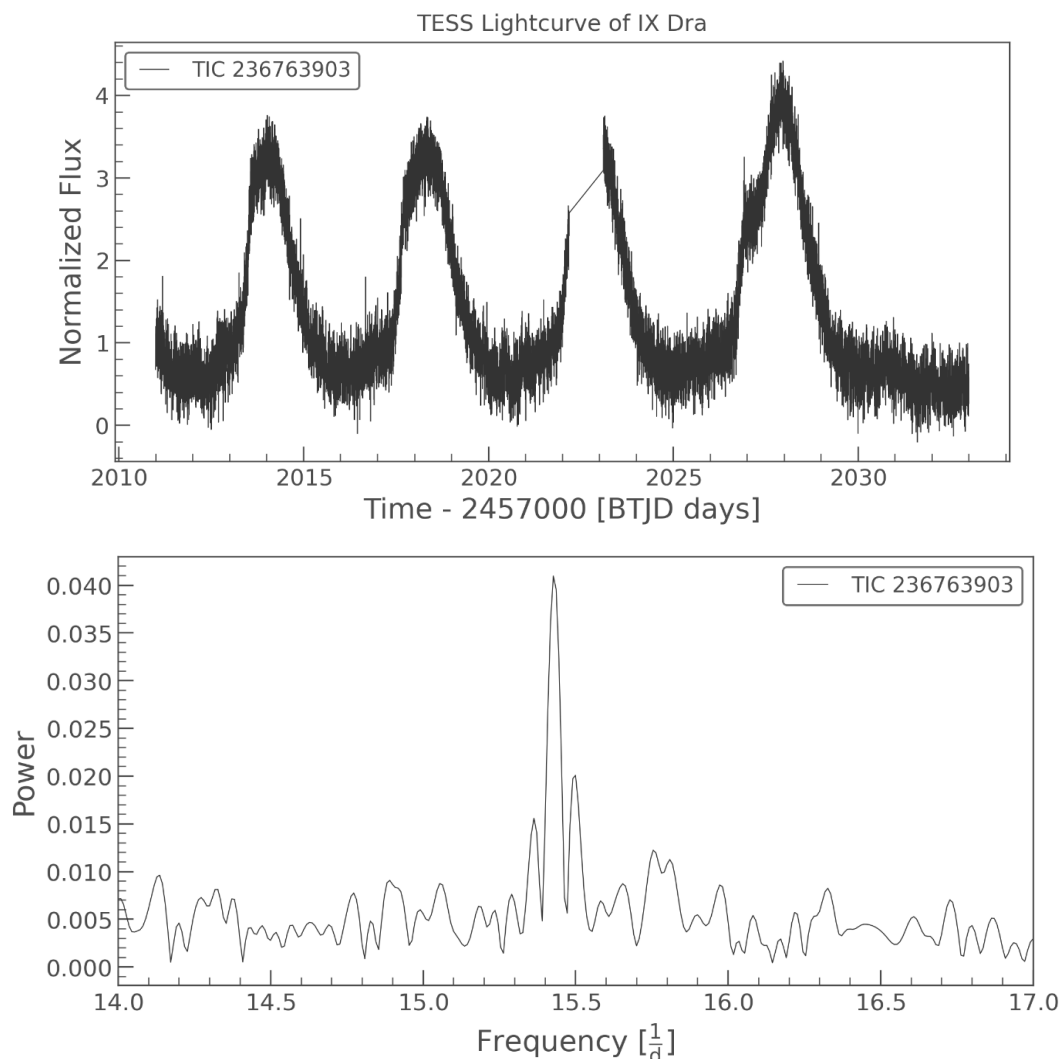


Figure 2 TESS Sector 26 light curve and period analysis.

## Determining the period excess

Otulakowska-Hypka, M. determined a value for  $P_{\text{sh}}$  of 0.06698 d. Results from the TESS space telescope Sector 25, which did include a superoutburst, gave a period of 0.067 d which is practically identical.

Using  $P_{\text{sh}} = 0.067$  d and  $P_{\text{orb}} = 0.0648$  d the period excess is 0.034. This is often expressed as 3.4%.  $\log \epsilon$  is approximately -1.5 corresponding to the solid triangle in Figure 1.

IX Dra can now confidently be assigned to the filled triangle position in Figure 1 and clustered with ER UMa and V1159 Ori (shown as empty triangles) on the upper branch of the evolutionary curve.

## Discussion

The new period excess of 0.034 (3.4%) places IX Dra, with ER Uma and V1159 Ori, as a system in which the orbital period is **decreasing**. The observational properties of IX Dra—specifically its rapid succession of normal outbursts and frequent superoutbursts—are consistent with the high mass-transfer rates found in systems approaching, rather than leaving, the period minimum.

## Summary

The evidence suggests that IX Dra is an active dwarf nova whose orbital period is decreasing as it approaches the period minimum and not a period bouncer.

## Acknowledgements

I acknowledge with thanks all BAA-VSS and AAVSO members who contributed observations on IX Dra as part of the UGER project. I hope they will continue doing so. I also thank AAVSO for choosing to observe IX Dra with one of their AAVSONet telescopes.

## References

**Knigge, C., Baraffe, I., & Patterson, J.** (2011). The Evolution of Cataclysmic Variables as Revealed by Their Donor Stars. *The Astrophysical Journal Supplement Series*, 194(2), 28.

**NASA.** (2026). *TESS Mission Site*. Available at: <https://tess.mit.edu/>

**Olech, A., Kędzierski, P., Złoczewski, K., et al.** (2003). IX Draconis – a curious ER UMa star. *Astronomy & Astrophysics*, 411(3), 483–491.

**Otulakowska-Hypka, M., & Olech, A.** (2013). IX Draconis – a period bouncer? *Monthly Notices of the Royal Astronomical Society*, 433(2), 1338–1343.

**Thorstensen, J. R.** (2020). Precision Orbital Periods for Thirty Cataclysmic Variable Stars. *The Astronomical Journal*, 160(4), 151.

# HD 89192 in Vela is an $\alpha^2$ Canum Venaticorum Variable

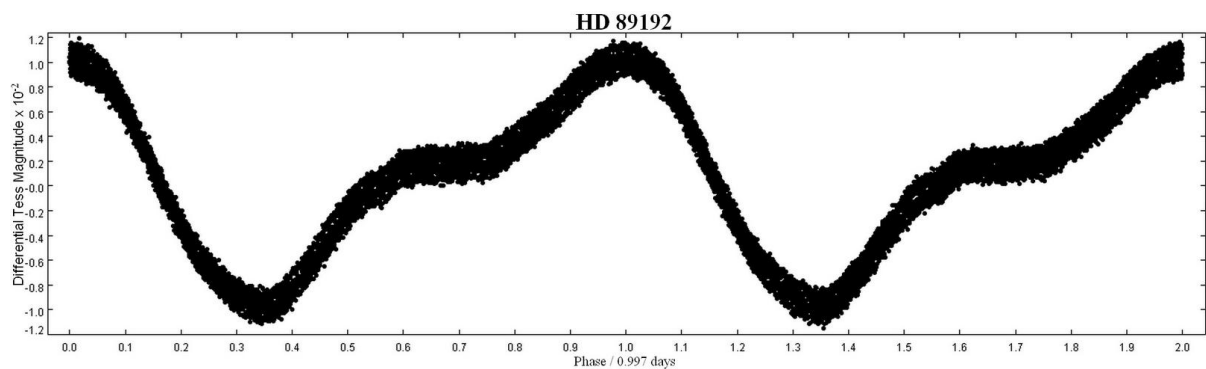
John Greaves

---

***The chemically peculiar A star HD 89192 is revealed to be an  $\alpha^2$  Canum Venaticorum variable of 0.997 day period with amplitude 0.024 TESS instrumental magnitude photometry.***

HD 89192

TESS-SPOC (Caldwell et al 2020[1]) photometry data were obtained from the mast.stsci.edu portal for the peculiar A star HD 89192 (spectral type ApCrEuSr where A is spectral type, p denotes a peculiar spectrum, with Cr, Eu and Sr denoting that the peculiarity is strong spectral lines of Chromium, Europium and Strontium respectively) then folded upon the derived period of 0.997 days as presented in the following figure of differential TESS instrumental magnitude, overall amplitude 0.024, and phase with two cycles shown for illustrative purposes. The particulars best fit an ACV ( $\alpha^2$  Canum Venaticorum) variable.



## Reference

[1] Caldwell, Douglas A.; Tenenbaum, Peter; Twicken, Joseph D.; Jenkins, Jon M.; Ting, Eric; Smith, Jeffrey C.; Hedges, Christina; Fausnaugh, Michael M.; Rose, Mark; Burke, Christopher; Research Notes of the AAS, Volume 4, Issue 11, id.201.

# NSV 4031 is a gamma Doradus variable after all

Christopher Lloyd

[cl57@ymail.com](mailto:cl57@ymail.com)

---

***NSV 4031 has already been comprehensively debunked as an eclipsing binary, but the data available at that time only allowed a relatively poor limit of a few hundredths of a magnitude on any other variation. Analysis of more recent TESS data shows that the star is a multiperiodic variable, with dominant periods in the 1-day range and semi-amplitudes of 3 mmag. In total some 19 periods have been recovered with semi-amplitudes above 0.1 mmag, suggesting that the star is a gamma Doradus variable, with no detectable variations at frequencies above 2 c/d.***

## Introduction

NSV 4031 (HD 70271, BD +45°1570, CSV 6628, SVS 1396 Lyn) is a ninth magnitude star in Lynx and was reported as a probable Algol-type eclipsing binary by Lange (1963). The report is based on a few days of visual observations made during dusk and claimed a variation of 0<sup>m</sup>. 8 on a likely period of about half a day. As a variable star NSV 4031 has been largely ignored, but it was included in the BAA VSS Eclipsing Binary Programme, in an effort to clarify its behaviour. Limited visual observations during 2003 showed no significant variation. In a detailed review of all the available data from the archives of the synoptic survey projects Tycho, ROTSE-I (NSVS), SuperWASP, ASAS-SN, TASS and the INTEGRAL OMC, plus new, dedicated observations, Lloyd et al. (2020) showed there was no evidence that the star was an eclipsing binary as suggested, or indeed that there was any variation above a few hundredths of a magnitude. The star is now given as 'constant' by [VSX](#), but is still listed as an eclipsing binary by Simbad.

## TESS data

Since the previous paper, data from the Transiting Exoplanet Survey Satellite (TESS, Ricker et al. (2015)) have become available for NSV 4031, which was observed in sectors 20, 47 and 60, in January 2020, 2022 and 2023, at the 30-minute, 10-minute and 200-second cadence respectively. The data were downloaded from the [MAST archive at the STScI](#), and both the high level science products (HLSP) Quick Look Pipeline (QLP) and [HLSP TESS-SPOC](#) photometry pipeline data have been examined. Each sector is observed over two 13.7-day orbits, but with, in this case, a few days lost each orbit for data download. Other small gaps can appear at the half-orbit points due to the high background, and limitations in the background removal frequently generates systematic trends or offsets in the fluxes between the two orbits in each sector, and even in the halves of each orbit.

Both the QLP and SPOC pipelines generate two variants of the target flux based on different approaches to flux extraction and background correction. These are the raw, simple aperture photometry, QLP-SAP and SPOC-SAP fluxes, and the QLP default detrended KSPSAP flux (now called DET\_FLUX) and the SPOC pre-search data conditioning PDCSAP fluxes. The KSPSAP and PDCSAP fluxes are detrended or filtered in a way that is intended to aid the search for exoplanet transits, but this generally plays havoc with eclipsing binary, and some other light curves. Even the most cursory examination of the light curves shows that the QLP-KSPSAP fluxes are very different, with the dominant variation being largely filtered out. The other data sets show less obvious differences through the sectors, but there are gradients between different orbits, particularly for the SPOC-PDCSAP data, and even for the SAP fluxes. The light curves of the QLP-SAP fluxes are shown in Fig 1.

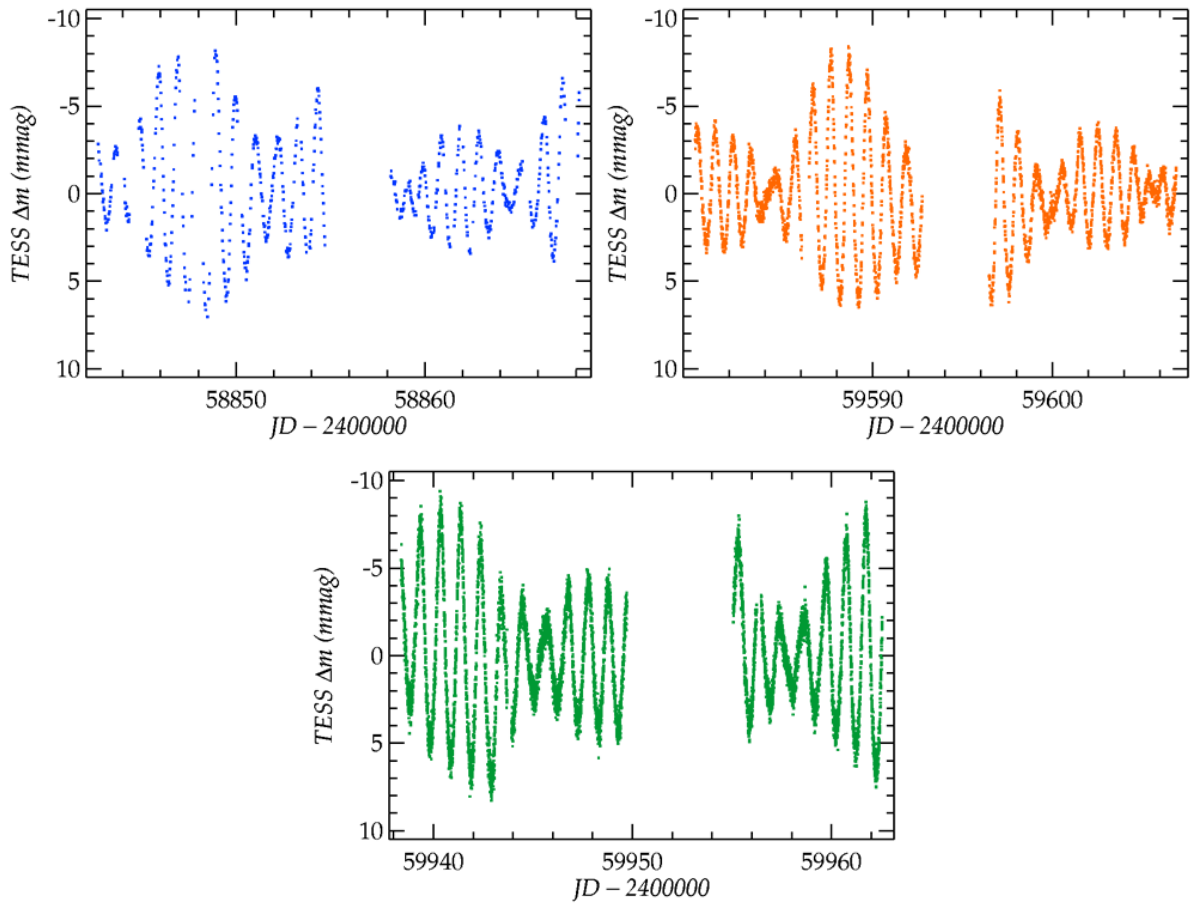


Figure 1: The TESS QLP-SAP light curves of NSV 4031 for sectors 20, 47 and 60, showing that the star is clearly a low-amplitude multiperiodic variable. The SPOC light curves are very similar, but with significant gradients through the different orbits, and the variation is largely suppressed in the QLP-KSPSAP photometry.

The data have been processed in a variety of different ways in an effort to find the most consistent set of frequencies, given the complexity of both the variations and the data. In the analysis of the individual sectors, it was found that different gradients through the orbits generated significant low-frequency features that compromised the detection of other, apparently real, weak frequencies. To address this issue a filtered QLP-SAP data set was created to suppress the low-frequency variations by subtracting a boxcar average with a window of 2 d, which progressively filters the frequencies at  $f < 0.5$  c/d. In all cases the apparent gradients through each sector were also removed. All three sectors were also analysed together, again using the filtered, detrended data.

The different data sets have been analysed by repeated application of a period search – fitting and subtraction loop down to some arbitrary limit. Frequencies were identified through both a Discrete Fourier Transform (DFT) and a Lomb-Scargle periodogram, and then refined and removed using a multi-frequency Fourier fitting routine of the form

$$m_k = c_z + \sum_{j=1}^n a_j \cos(2\pi f_j T_k + \varphi_j)$$

where  $m_k$  is the observed magnitude at time  $T_k$ ,  $j = 1, \dots, n$  is the number of frequencies, with just the single harmonic for each frequency,  $\phi_j$  is the phase offset for each frequency  $j$ , and  $c_z$  is the constant level for any particular subset of the data. Each sector was first treated separately, and the frequency search was continued until the features were only occurring in one data set. However, some of these single-sector frequencies did appear before some of the multi-sector features. Most of the frequencies identified were common between the raw QLP and SPOC SAP, and the filtered QLP-SAP data, but this not always the case. In general, the precision on the frequencies from the individual sectors is relatively poor, typically  $0.004c/d$ , and is limited in part by the short runs of data. It also became clear that the noise level in sector 60, which contains most of the data, is significantly worse than the other two sectors.

The periodogram of the combined filtered data set (see Fig. 2) showed significant fringing around each feature due to the 1-yr alias (at  $0.0027c/d$ ) and this seriously hampered the identification of the 'correct' frequency. There was often little discrimination between the alternatives and the process became quite fragile. To resolve this issue, it was necessary to test the different frequency trees, but this was limited to the stronger features. For the weaker features this process was not followed due to the myriad of possibilities, and the alias suggested by the periodogram was used. The danger of this approach is that false features can be generated if the incorrect alias is removed. The frequency search was continued until all the frequencies from multiple sectors were identified.

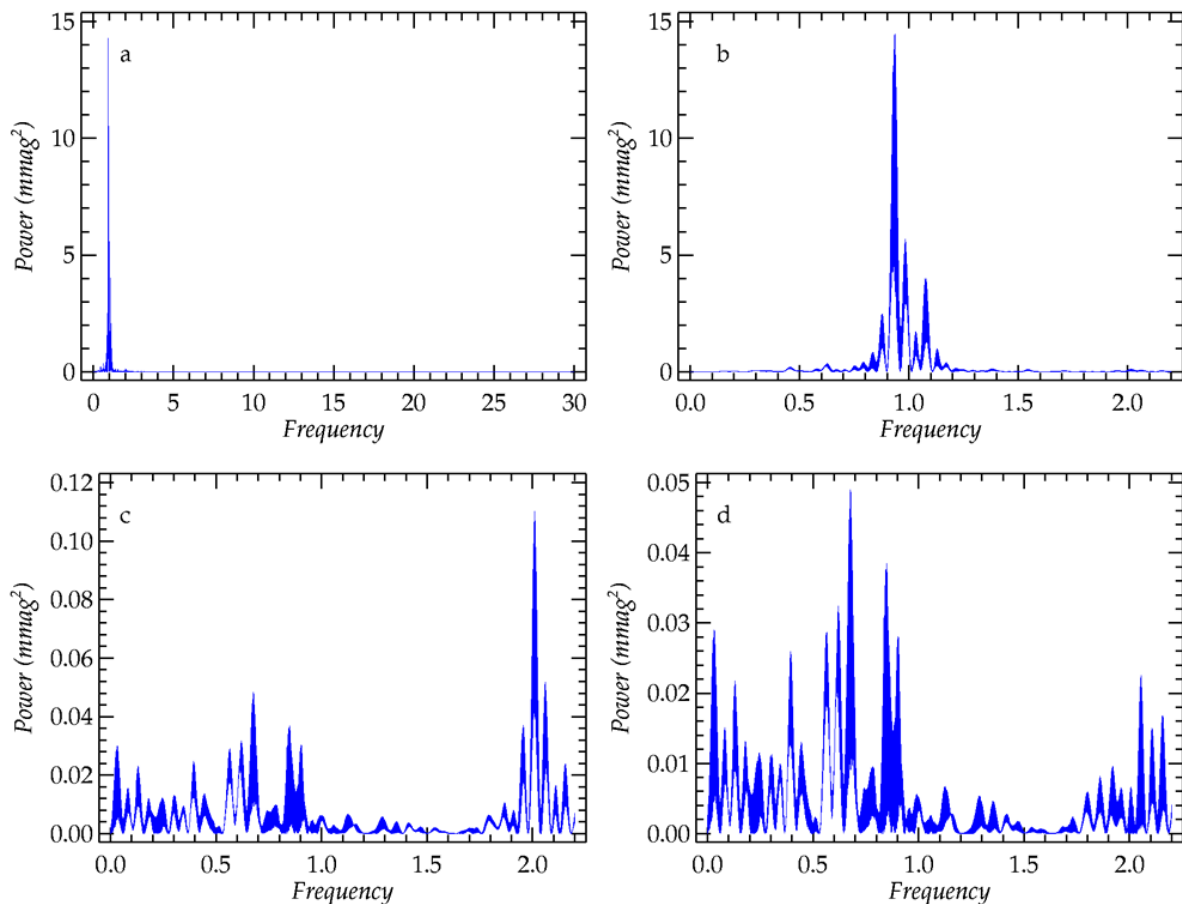


Figure 2: The DFT periodograms of the combined filtered QLP-SAP data. The four plots show the DFT of the data prior to the removal of any frequencies to  $30 c/d$  (a) and the expanded region to  $2.2 c/d$  (b), where all the power is concentrated, and (c) after the removal of the three frequencies near  $f = 1 c/d$ , so showing  $f_4$ , then (d) after four frequencies, showing  $f_5$  and higher frequencies. The dramatic difference in the power of the main frequencies is clear, and also the potential confusion of the weakest features.

## Results

The main arbiter of significance was the repeated detection of a particular frequency in the different sectors, but even this has its limitations due to the poor frequency resolution of each subset. Ultimately 19 frequencies have been identified and these are listed in Table 1, but there is still some ambiguity. The table lists each frequency in order of detection in the combined QLP-SAP detrended filtered data, with the most likely corresponding frequencies found in the individual sectors. Some of these associations may seem a little loose. If a consistent frequency is present in the raw QLP-SAP data or SPOC-SAP data then that is indicated by \* or #. These data are not independent, but they do help to provide confirmation that the features found are not just a product of the filtering process.

The main issue is the ambiguity in  $f_3$ , which in the alternate tree corresponds to the lower 1-yr alias of the frequency in the primary listing. Although the fits using this alias generate almost identical residuals, it is relegated to an alternative as the uncertainty on the frequency is about three times the optimal value. Perhaps surprisingly, most of the frequencies in this alternative tree are also present in the primary tree, except for the weak features,  $f_{15}$ ,  $f_{16}$  and  $f_{18}$ , suggesting they may be quite robust.

The first ten frequencies each have multiple detections in the individual sectors, and in the unfiltered data as well, but  $f_{11}$  is the first that shows no previous appearances. Two other weak signals,  $f_{16}$  and  $f_{17}$ , also do not appear in the individual sectors, and the last one in the table, which only appears in one sector, is not recovered from the combined data. These have low confidence. Given the issues with the gradients through the data and the filtering process, there has to be some uncertainty over the low-frequency features, but having said that, they have survived the multiple-appearance test, so they cannot be dismissed out of hand. The maximum semi-amplitude of any features beyond 2.2 c/d up to 30 c/d is less than 0.03 mmag.

The frequencies listed in Table 1 are plotted with their semi-amplitudes in Fig. 3. The three main features lie close to 1 c/d, with  $f_4$  and some weaker frequencies near 2 c/d. There is also a relatively even spread of weak features between zero and 1 c/d. The distribution does not appear to be totally random, with a similar spacing between  $f_2$  and  $f_3$ , the two features near  $f_4$  at  $f = 2.05$  and  $2.15$  c/d, and the two lowest frequencies at  $f = 0.030$  and  $0.131$  c/d. To search the spacings more systematically, the differences between all the frequencies up to 0.3 c/d have been calculated and are plotted in Fig. 3. These show a distinct concentration near 0.101 c/d, but the statistics are poor, and this spacing does not appear to apply to many frequencies.

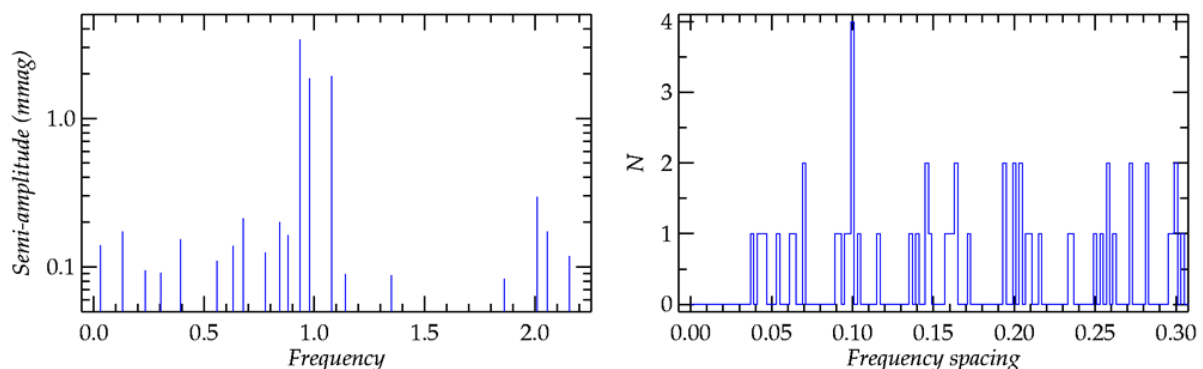


Figure 3: (Left) The frequency and amplitude distribution of the frequencies found in the combined filtered QLP-SAP data listed in Table 1. The amplitude scale is logarithmic. (Right) The histogram of the frequency spacings.

Table 1: Table of frequencies recovered from the TESS QLP SAP filtered data

Id		Frequency( $\sigma$ )	A( $\sigma$ ) mmag	Source	Frequency( $\sigma$ )	A( $\sigma$ ) mmag	Sector
$f_1$	*#	0.93555(5)	3.469(8)	All	0.9342(15)	3.249(20)	47
					0.9349(16)	3.505(22)	20
					0.9383(28)	3.779(32)	60
$f_2$	*#	1.07733(5)	1.918(8)	All	1.0758(13)	1.966(18)	20
					1.0765(10)	1.917(11)	47
					1.0780(13)	1.796(12)	60
$f_3$	*#	0.97862(6)	1.848(8)	All	0.9731(36)	2.101(34)	60
					0.9749(22)	1.936(20)	20
					0.9763(22)	1.916(14)	47
$(f_3)$		0.97591(17)	1.886(10)	All			
$f_4$	*#	2.01018(5)	0.339(8)	All	2.0082(26)	0.267(11)	47
					2.0085(20)	0.404(10)	60
					2.0161(111)	0.270(43)	20
$f_5$	*#	0.67695(12)	0.219(8)	All	0.6641(95)	0.254(19)	20
					0.6843(40)	0.212(12)	47
$f_6$	*#	0.84226(15)	0.202(8)	All	0.8312(40)	0.379(13)	47
					0.8417(47)	0.178(13)	60
$f_7$	*	0.03044(31)	0.130(7)	All	0.0376(56)	0.155(15)	60
					0.0376(62)	0.117(15)	20
$f_8$		0.39411(12)	0.156(8)	All	0.3951(23)	0.242(10)	60
					0.4094(33)	0.086(10)	47
$f_9$	*#	2.05603(21)	0.169(7)	All	2.0427(141)	0.162(38)	20
					2.0520(28)	0.236(10)	47
$f_{10}$	*	0.13120(17)	0.173(7)	All	0.1328(41)	0.206(12)	60
					0.1371(28)	0.088(10)	47
					0.1464(9)	0.207(19)	20
$f_{11}$		0.55932(15)	0.134(7)	All			
$f_{12}$	*#	2.15754(20)	0.129(7)	All	2.1517(20)	0.144(10)	47
$f_{13}$	*	0.30389(13)	0.128(7)	All	0.3043(24)	0.159(10)	60
					0.3057(48)	0.210(18)	20
$f_{14}$	*#	0.88158(31)	0.131(8)	All	0.8701(37)	0.318(18)	20
					0.8795(35)	0.356(16)	47
$f_{15}$	*	0.63092(32)	0.142(8)	All	0.6181(21)	0.257(12)	60
					0.6314(121)	0.104(24)	20
					0.6409(38)	0.147(11)	47
$f_{16}$		0.77700(34)	0.125(8)	All			
$f_{17}$		0.23244(29)	0.095(7)	All			
$f_{18}$	*#	1.34973(19)	0.088(7)	All	1.3563(28)	0.091(10)	47
	*#			solo	1.9226(27)	0.133(10)	60

\* frequency present in original unfiltered QLP SAP data

# frequency present in original unfiltered SPOCSAP data

The frequencies and amplitudes of the variations place the star firmly in the gamma Doradus range, and more specifically in the SYM or ASYM classification of Balona et al. (2011). The lack of any significant variation at higher frequencies means that this is not a delta Scuti star or a hybrid variable. See Wang et al. (2025) for a helpful comparison. The SYM and ASYN stars tend to have one or two dominant, closely-spaced frequencies, and the SYM stars appear to have, subjectively, more symmetrical light curves. They are the most common  $\gamma$  Dor type, tend to be marginally cooler than the ASYM type, and have relatively low amplitudes compared to other variants. Compare Fig. 1 and 2 with Figs. 1 and 2 from Balona et al. (2011). In the previous paper, Lloyd et al. (2020) examined the

spectral energy distribution of NSV 4031 and concluded that it was best matched to a spectral type of F5IV, with little reddening, at a temperature  $T_{\text{eff}} \simeq 6500$  K. The absolute magnitude was calculated as  $M_V \simeq 2.4$ , about a magnitude above the ZAMS, and consistent with the slightly evolved spectral type. More recent data from Gaia DR3 (Gaia Collaboration et al., 2023) gives similar results with  $T_{\text{eff}} = 6734$  K and  $M_G = 2.2$ , equivalent to  $M_V = 2.3$ . Gaia's extended Apsis processing chain (Creevey et al., 2023) gives  $\log L/L_{\odot} = 0.87$ , which with  $\log T_{\text{eff}} = 3.83$  places the star solidly within the cooler tail of the SYM sample in Balona et al. (2011)'s Fig. 4.

In short-period pulsating stars there is a complex relationship between pulsation and rotation, and the rotational properties of these variables are not the same as normal stars (see e.g., Wang et al., 2025). Rotation also has an effect on the appearance of the frequencies and can produce splitting in different forms. In  $\gamma$  Dor stars the rotational period is typically close to the pulsation period, and this can lead to variety of frequency-spacing patterns (see e.g., Van Reeth et al., 2015, for some background and examples). While there is some suggestion of a pattern in Fig. 3 it is hardly convincing, but it would not be unexpected and may become clearer with further observations.

## Conclusion

New TESS observations have shown that NSV 4031 is a low-amplitude  $\gamma$  Dor variable with dominant clusters of frequencies near 1 and 2 c/d, and a spread of very weak features at lower frequencies. Its physical properties from Gaia confirm that it lies at the heart of the  $\gamma$  Dor distribution, close to the red edge of the instability strip and above the ZAMS.

## Acknowledgements

The author is indebted to John Greaves who serendipitously discovered the complex variations in the TESS data. This paper includes data collected by the TESS mission, which are publicly available from the Mikulski Archive for Space Telescopes (MAST). Funding for the TESS mission is provided by NASA's Science Mission directorate. The author is pleased to acknowledge use of NASA's Astrophysics Data System Bibliographic Services. This research has made use of the SIMBAD database and the VizieR catalogue access tool, CDS, Strasbourg, France (DOI: 10.26093/cds/vizieer).

## References

- Balona, L. A., Guzik, J. A., Uytterhoeven, K., et al., 2011, *MNRAS*, **415**, 3531
- Creevey, O. L., Sordo, R., Pailler, F., et al., 2023, *A&A*, **674**, A26
- Gaia Collaboration, Vallenari, A., Brown, A. G. A., et al., 2023, *A&A*, **674**, A1
- Lange, G. A., 1963, *Astronomicheskij Tsirkulyar*, **246**, 3
- Lloyd, C., Conner, D., Pickard, R., et al., 2020, *Open European Journal on Variable Stars*, **207**, 1
- Ricker, G. R., Winn, J. N., Vanderspek, R., et al., 2015, *Journal of Astronomical Telescopes, Instruments, and Systems*, **1**, 014003
- Van Reeth, T., Tkachenko, A., Aerts, C., et al., 2015, *ApJ Suppl*, **218**, 27
- Wang, J., Chen, X., Deng, L., et al., 2025, *ApJ*, **978**, 53

# A DIY Dual Beam Polarimeter

John Simpson

[john.jean.simpson@gmail.com](mailto:john.jean.simpson@gmail.com)

---

***This article gives a brief description of the design, construction, calibration and use of a DIY dual beam linear polarimeter.***

## Introduction

Polarimetry informs about the polarisation state of light. When starlight is asymmetrically scattered, for example by the stellar environment itself, or circumstellar dust and gas, information is encoded into the polarisation state whose measurement and analysis can be used to recover characteristics of the source and its geometry as well as the medium through which that light has passed.

I became curious and interested in the role of linear polarimetry in astronomy after reading an article by G. Cole about a dual beam polarimeter he'd built [1] to support the AAVSO's epsilon Aurigae campaign. A subsequent literature search revealed details about designs, optical components and their availability and also the precisions necessary to make astronomically useful observations, typically degree of polarisation  $[P] < 0.1\%$  and polarisation angle  $[PA] < 1^\circ$ . It seemed to me that there was a possible role in astronomical polarimetry for amateurs with DIY equipment. Initially I used a 200 mm f/2.8 canon lens equipped with a rotatable linear polarising filter as analyser, scribed at 45 degree intervals and coupled to various cameras - a low-cost set-up to experiment with. My experience with this simple set-up proved enough to encourage me to take the next step, the purchase of a Wollaston Prism [WP] to act as analyser plus Half Wave Plate [HWP] to modulate the incoming light beam. The WP [actually two prisms cemented together], is constructed using birefringent material and separates the incoming light beam into two images with orthogonal polarisation states, ordinary 'o' and extraordinary 'e', which allows the impacts of varying observing conditions between images to be removed during processing. The HWP acts as a retarder and sits inside a simple manually operated rotor [built with the help of a good friend and former colleague]. Rotating the HWP modulates the incoming polarised light whilst keeping the rest of the optical train fixed, Figure 1 shows the final build.

## Design

Light from the attached Celestron 150 mm SCT [C6] passes through a Thorlabs HWP [type WP10m, 400 nm-700 nm] mounted in a manually operated rotation stage. The HWP is held in place by grub screws and mounted inside a machined Tufnol disc and cylinder assembly having 16 x 22.5 degree possible rotor positions. This is locked in place for imaging at each rotor position by a removeable locating pin which passes through holes in the Tufnol disc and each side of the aluminium support frame.



Figure 1. Dual Beam Polarimeter mounted on Celestron [C6], 150 mm objective Schmidt Cassegrain Telescope.

The frame is attached on one side to the SCT and on the other side to an adapter within which is mounted a Thorlabs WP [type WPQ10, 10 mm x 10 mm, 400 nm – 2  $\mu$ m]. Separation of ‘o’ and ‘e’ beams exiting the WP is 1 degree. Peep holes in the Tufnol cylinder and scribe lines on the housing and adapter allow alignment to  $\sim 1^\circ$  of HWP to housing and housing to adapter to WP. Subsequent on-sky calibration allows correction of any build misalignments. The ‘o’ and ‘e’ beams pass through a Baader Filter Box with slides which allow choice of photometric B, V, R, I – Band filters to be used [I use mainly V-Band] and then to an ATIK 314L+ cooled CCD camera with 4.65  $\mu$ m pixels, a gain of 0.273 electrons/ADU and read out noise 4.76 e. Coupled to the Celestron C6 telescope, the provided Field of View [FOV] is 17.2 x 12.9 arcmin with an image scale 0.74 arcsec/pixel resulting in a separation between ‘o’ and ‘e’ beam images of 130 arcsec. I chose not to collimate which means that there is some inherent defocussing of the ‘o’ and ‘e’ images. I set the focus midway between ‘o’ and ‘e’ focal positions, which gives a Full Width Half Maximum [FWHM] of typically 5-8 pixels in my average seeing conditions. Figure 2 shows some images typical of those acquired using the polarimeter, each star in the FOV appears as a ‘o’, ‘e’ pair. I was pleasantly surprised to find that neither Astrometry.net nor ASTAP are confused by the presence of ‘o’, ‘e’ image pairs and will plate solve images provided there are sufficient stars in the FOV. My imaging is controlled via laptop using a mixture of dedicated ATIK Capture software and SharpCap Pro. I use a permanently situated Celestron AVX mount, but mount/dis-mount the telescope and imaging equipment for each observing session. The same laptop used to support imaging also is used for mount set up and control in combination with Celestron Nexstar hand-controller and CPWI software. I augmented this with ZWO’s ASIAIR when it became available and currently am in the process of switching over to using Nighttime Imaging ‘N’ Astronomy [NINA] - this is a work in progress.

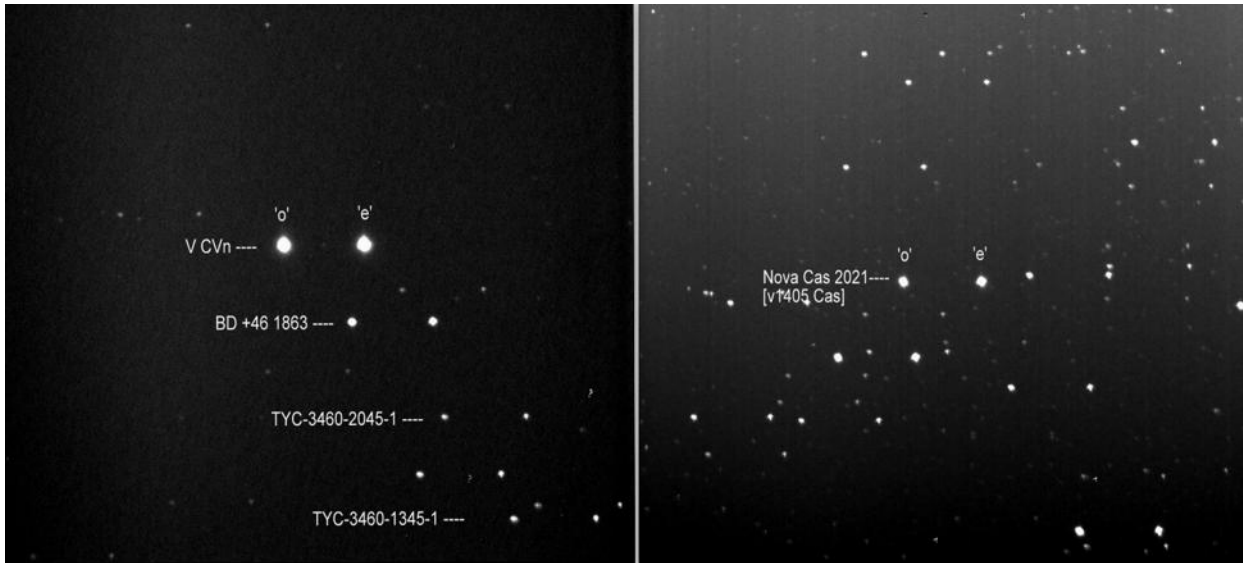


Figure 2. Some typical examples of 'o' and 'e' images of V CVn and Nova Cas 2021 obtained using dual-beam polarimeter.

### Measurement Acquisition

My workflow in a typical observing session after the equipment has powered up and stabilised begins with mount polar alignment and then for each target, slew and acquisition followed by the main polarimetric imaging sequence which normally includes collecting a series of measurements at different HWP rotation angles to sample the polarisation waveform. I normally use just 4 positions [0°, 22.5°, 45°, 67.5°] which are sufficient to recover the polarisation state. In general, since most exposure times are short, I choose to rely on achieving good polar alignment [ $< 1$  arcmin] and accept what mount tracking delivers in terms of image drift across the detector. The number of measurements taken at each rotation angle depends on target magnitude. Practically, with the C6, I can manage targets down to magnitude  $\sim 8$ , occasionally down to magnitude  $\sim 10$  with good observing conditions. The number of observations vary but typically lie between 25 – 100 at each HWP position. With enough samples, the measurements can be treated as though normally distributed, with a small correction applied to their standard deviations based on the number of samples. Exposure times are generally  $< 10$  seconds. I have used as low as 0.1 second [for beta Cas] and as long as 30 seconds [for T CrB]. Polarimetry is a photon hungry process needing  $\sim 10^6$  photoelectrons to achieve degree of polarisation precisions of  $\sim 0.1\%$ . Ideally, especially where equipment is mounted/dis-mounted each evening as in my case, every session needs to include acquisition of polarimetry measurements of 'standard' stars for calibration purposes. I take bias and dark images at each exposure time at the end of each session and acquire flat field images offline for each of the HWP angles.

### Measurement Processing and Polarisation State Recovery

The initial processing of polarimetry images is identical to that used in photometry as is also the software employed and starts with bias, dark and flat-field correction of images. I use AstrolmageJ, but any suitable photometry software will do the job, I have used both AIP4Win and Astro-Art as well. Rules similar to those in photometry apply when it comes to selection of photometric apertures. I find it useful each time to check a range of apertures and the related degree of polarisation Signal to Noise Ratio [SNR]. The main difference between polarimetric and photometric data reduction is that the differential intensity measurements are made between the separated 'o' and 'e' measurements of the target star rather than between target and chosen suitable comparison stars. This avoids some of the difficulties arising from differences between comparison stars and the target which can occur in

photometry. I use either the AstrolImageJ DP Coordinate Converter link to SIMBAD to set target Right Ascension [RA] and Declination [DEC] for image processing or, if plate solved, the solutions provided by Astrometry.net or ASTAP.

As mentioned earlier, recovery of the polarisation state vector normally makes use of 4 HWP measurement sequences to acquire 'o' and 'e' image intensities  $I_o$  and  $I_e$  which are functions of  $I$ ,  $Q$  and  $U$ . The parameters  $I$ ,  $Q$ ,  $U$  devised by Stokes in 1851 [2] are used to describe partially polarised light and the accepted practice in linear polarimetry is to work with Normalised Stokes Parameters [NSP],  $\hat{Q} = Q/I$  and  $\hat{U} = U/I$ .

$$I_o = \frac{1}{2}I[1 + \hat{Q}\cos4\theta + \hat{U}\sin4\theta] \quad [1]$$

$$I_e = \frac{1}{2}I[1 - \hat{Q}\cos4\theta - \hat{U}\sin4\theta] \quad [2]$$

Several different methods exist for processing measurements to recover  $\hat{Q}$  and  $\hat{U}$  including either so called 'double difference' or 'double ratio' [Bagnulo et al, [3], least squares [Ramirez et al, [4] and Fourier analysis [Patat et al, [5]. I mostly use the 'double difference' method in which the sequences for HWP angles  $[0^\circ, 45^\circ]$  and  $[22.5^\circ, 67.5^\circ]$  are paired and processed together to recover  $\hat{Q}$  and  $\hat{U}$ .

$$\hat{Q} = \frac{1}{2}\Sigma\{[(I_o - I_e)/(I_o + I_e)]_0 - [(I_o - I_e)/(I_o + I_e)]_{45}\} \quad [3]$$

$$\hat{U} = \frac{1}{2}\Sigma\{[(I_o - I_e)/(I_o + I_e)]_{22.5} - [(I_o - I_e)/(I_o + I_e)]_{67.5}\} \quad [4]$$

The final step in processing is to calculate the degree of polarisation and position angle.

$$P = \sqrt{[\hat{Q}^2 + \hat{U}^2]} \quad [5]$$

$$PA = \frac{1}{2} \arctan [\hat{U}/\hat{Q}] \quad [6]$$

In low SNR situations, since  $P$  is positive definite, it is necessary to make bias corrections to the calculated degree of polarisation by removing the measurement error from the estimate via  $\sqrt{[P^2 - \sigma_P^2]}$ , [Wardle & Kronberg, [6]. For data reduction I use a set of Excel Worksheets which directly accept the text file outputs of image intensities generated using AstrolImageJ.

### Calibration on-sky

Calibration on-sky against internationally accepted standards provides answers to the questions; how sensitive is my equipment, what is its precision? It also provides a robust basis for comparing results obtained with those of others. There are two polarimeter characteristic which need calibration. The first is instrumental polarisation. This is achieved by comparing instrumental measurements of low polarisation standard stars with their catalogue values. The difference between the two is the instrumental polarisation in accepted equatorial coordinates, to be subtracted from every target measurement. The determined values for my polarimeter are small.

$$\hat{Q}_{instr} = -0.005\% \pm 0.015\% \quad \hat{U}_{instr} = -0.029\% \pm 0.017\%$$

In general, for systems with inherent symmetry such as SCT's or refractors which avoid any oblique reflections, instrumental polarisation can be expected to be low. The night-to-night scatter of repeated measurements of the same low polarisation standards also provides a measure of the polarimeter's ability to detect small polarisation levels. For my polarimeter these values lie in the range  $[\sim 0.03\% \text{ to } 0.07\%]$ .

The second characteristic requiring calibration is the polarisation position angle as measured in the instrument reference frame. Comparing measurements of high polarisation standard stars with their catalogue values determines the offsets needed to transform measurements made in the instrument frame into the internationally accepted on-sky equatorial coordinate frame. The same comparison

enables identification of any degree of polarisation scaling correction. If plate solved images are obtained, individual HWP and WP misalignments from their reference positions can be determined.

### Position Angle and Degree of Polarisation

When it comes to establishing position angle offsets, one of the challenges facing amateurs is the availability of bright, high polarisation standards and the consistency of their values quoted in different sources. In some instances, differences between values for standards in different catalogues can be of the order of a degree or more. The most common approach is for observers to agree a campaign calibration standard or set of standards, so as to avoid incorporating differences between catalogue values into the datasets. Figures 3 and 4 show the on-sky calibration characteristics for my polarimeter.

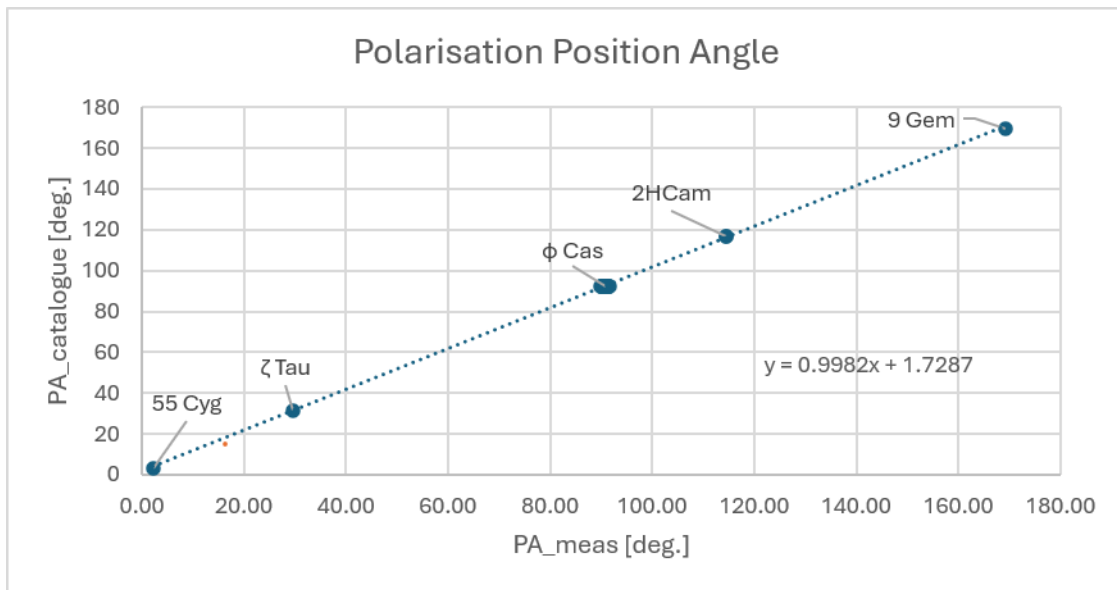


Figure 3. Position Angle Calibration using multiple high standards measurements.

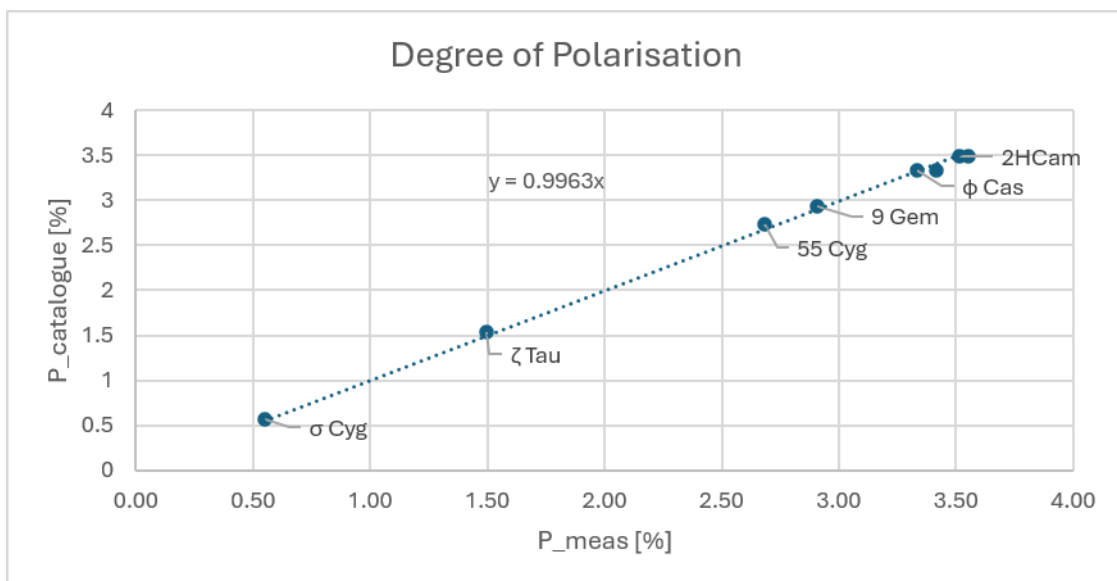


Figure 4. Degree of Polarisation P Calibration using multiple high standards.

## Performance versus Magnitude

As mentioned earlier, polarimetry is a photon hungry process and a good yardstick to establish is shown in Figure 5 where I have plotted a best fit of what my polarimeter achieves in V-Band when coupled to the Celestron C6 SCT in terms of the detected number of photoelectrons per pixel per second measured at a variety of different target magnitudes. Figure 6 shows how that translates into errors in degree of polarisation actually achieved against V-Band magnitude for various targets observed.

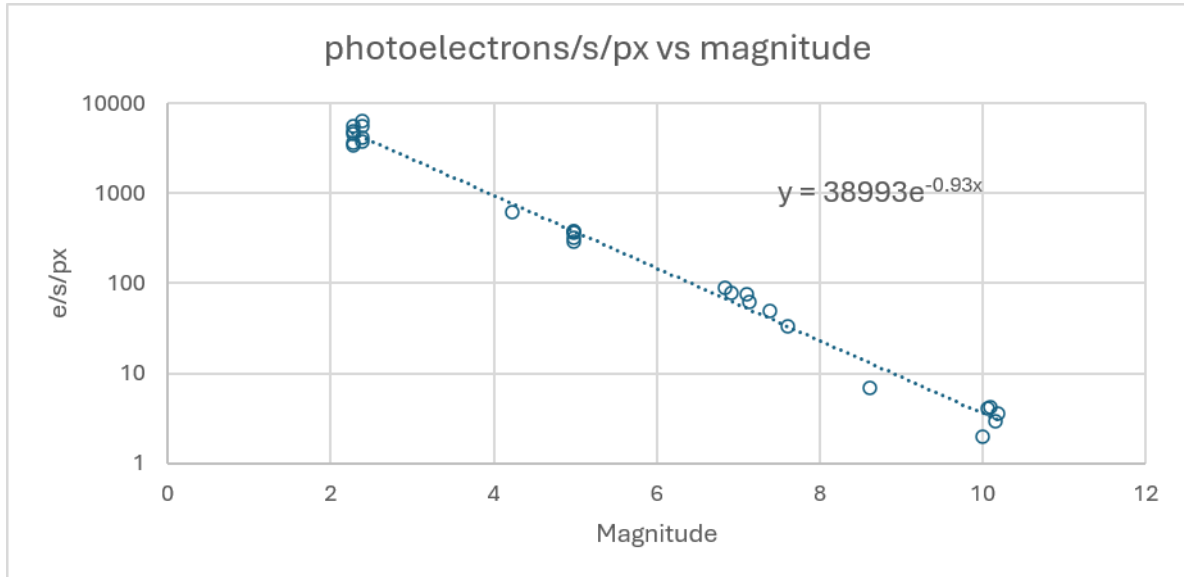


Figure 5. Flux vs Target Magnitude (photoelectrons/px/sec).

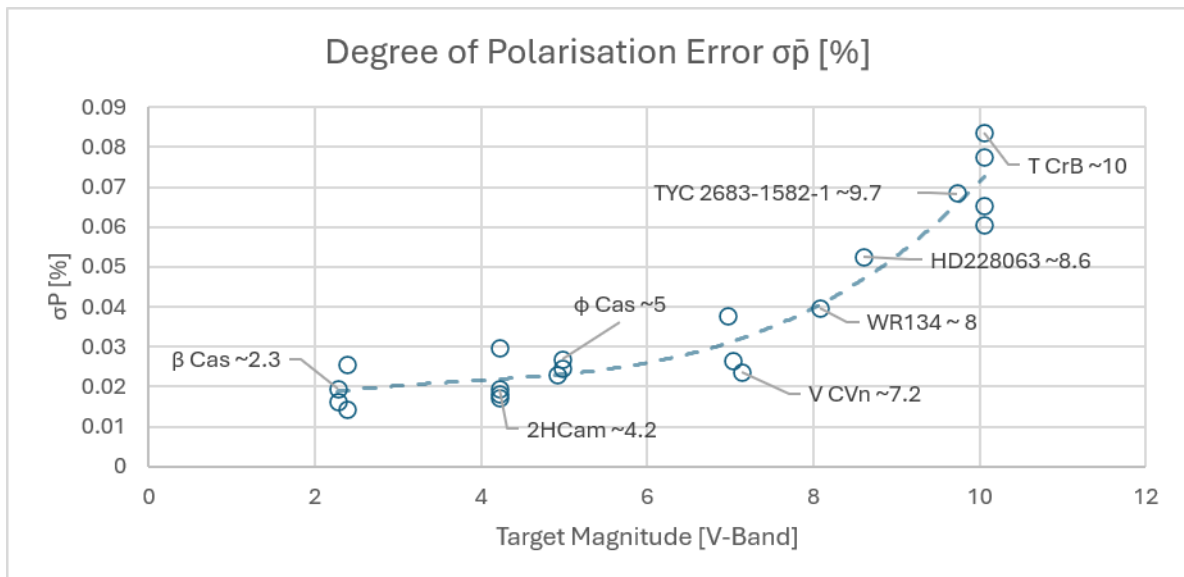


Figure 6. Degree of Polarisation standard error of the mean vs Target V-Band Magnitude.

The polarimeter has been used to support the study of a variety of targets. After posting some typical results on the BAA website, I was contacted by another amateur in the BAV (Nicolaus Steenken) who'd followed a very similar path of discovery to mine, and he and I have since worked together on various targets including AH Cep [7], WR134 & V CVn [8]. V CVn is a 'runaway' star suspected to have a bow shock, and it displays an inverse correlation between its magnitude and its degree of polarisation. Our measurements revealed evidence of a lead/lag behaviour in this characteristic and Figure 7 shows a good example of this behaviour. As well as V CVn, my current targets include T CrB, 69 Ori and  $\gamma$  Cas.

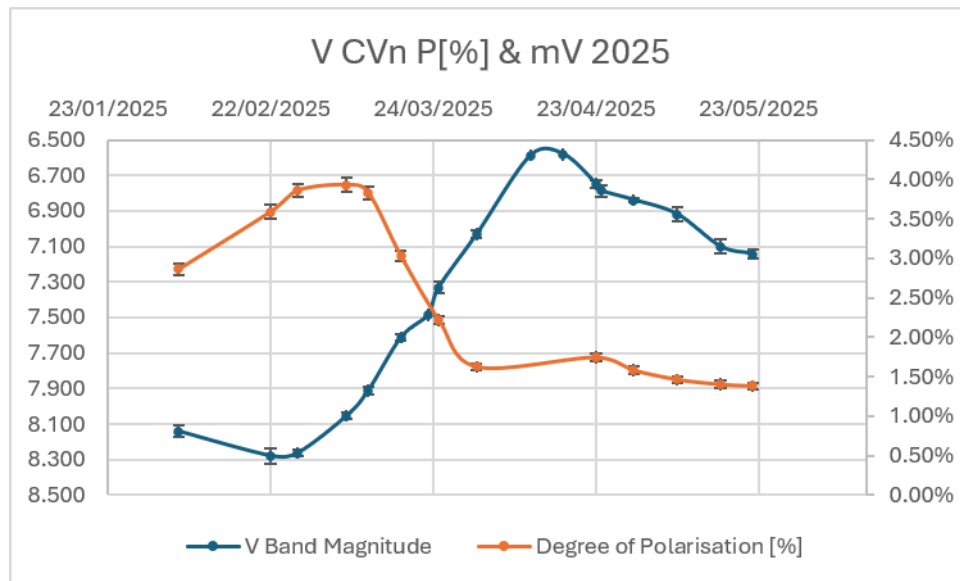


Figure 7. V CVn inverse correlation of V-Band Magnitude and phase lag with respect to Degree of Polarisation.

## Conclusions

In this short article, I've tried to illustrate what can be achieved in polarimetry at the level of amateur. In my own case starting from scratch with very little in the way of knowledge base or experience to tap into from other amateurs, it has proved possible to design and construct a dual beam polarimeter with a polarisation sensitivity of around 0.05% capable of measuring the fractional polarisation of high polarisation targets with precision  $<0.1\%$  and position angle  $<1^\circ$ . With sufficient aperture, campaigns involving targets brighter than magnitude  $\sim 10$  can provide a fertile ground where the amateur can make valuable contributions. For me, it has been a thoroughly absorbing, interesting and challenging experience and the polarimeter is a joy to use.

## References

- [1] G. Cole., Polarimetry of epsilon Aurigae, from November 2009 to January 2012, The Journal of the American Association of Variable Star Observers, vol. 40, no. 2, p. 787
- [2] Stokes, G. G. (1851). On the composition and resolution of streams of polarized light from different sources. Transactions of the Cambridge Philosophical Society, 9, 399.

- [3] Bagnulo. S., et al., Stellar Spectropolarimetry with Retarder Waveplate and Beam Splitter Devices, 2009, PASP, 121, 993
- [4] Ramirez. E.A., Solvepol: a reduction pipeline for imaging polarimetry data. arXiv.1512.09088 v2 [astro-ph.IM] 20 Dec. 2016
- [5] Patat. F., & Romaniello. M., Error Analysis for Dual-Beam Optical Linear Polarimetry, 2006, PASP, 118, 146
- [6] Wardle. J.F.C., & Kronberg. P.P., The linear polarisation of quasi-stellar radio sources at 3.71 and 11.1 centimetres., ApJ, 194, 249-255.
- [7] Steenken. N., Simpson. J., Welchen Zusammenhang gibt es bei dem Bedeckungsveränderlichen AH Cep zwischen der Lichtkurve und der variablen Polarisation? <https://www.bav-astro.eu/rb/rb2020-1/9.pdf>
- [8] Neilson. H, Steenken. N., Simpson. J., Ignace. R., Shrestha. M., Erba, C., Henson. G.D., A Multi-Year Photopolarimetric Study of the Semi-Regular Variable V CVn and Identification of Analogue Sources, arXiv.2306.15771

# Some Memories of Peter Francis Williams

John Toone

[enootnhoj@btinternet.com](mailto:enootnhoj@btinternet.com)

---

***Some personal memories and a summary of the astronomical work of Peter Williams who was an outstanding visual observer of variable stars during the years 1971-2025 operating from Sydney, Australia.***

I was deeply saddened to learn from Peter Williams wife Linda that Peter passed away on the 3<sup>rd</sup> March 2026 after a short fight with treatment for secondary melanoma. Peter was aged 70 and I was in email correspondence with him as recently as 3<sup>rd</sup> January 2026 with no hint of any health issues. I can quote the following extract from Peter's last email:

*I have just started working on a PowerPoint presentation for a talk I have been asked to present to the Sydney City Skywatchers (formally the BAA NSW Branch!) at the historic Sydney Observatory this coming July 2026. This will be along the lines of "Some Stars Do & Some Stars Don't – Reflections on 55 Years of Variable Star Observing." It is currently a work in progress...*

Peter was one of the very best visual observers of variable stars that the World and in particular the Southern Hemisphere has ever produced. Peter commenced observing variable stars in 1971 and reached the 100,000<sup>th</sup> observation milestone on 26<sup>th</sup> November 2004 [1] followed by the 200,000<sup>th</sup> observation milestone on 4<sup>th</sup> July 2021 (only the 12<sup>th</sup> observer to do so) [2]. His observational total at the end of September 2022 stood at 207,790 [3]. He continued to be productive making 3,495 observations in 2024 [4] and I know that he was still observing at the end of 2025 as he reported to me an observation of AO Cru made on the 24<sup>th</sup> December.

Based in the Heathcote suburb of Sydney, Australia; Peter observed a wide range of variable types and concentrated upon stars that the majority of the northern hemisphere observers could not reach (Figure 1). In fact, Peter investigated many far south objects that had limited information and uncertain designations. Through careful visual photometry Peter confirmed Mira star designations and determined periods for: IY Car, YY Cen, NSV5087 Cen, NSV19431 Cen, SS Cru, EO Eri, SW Hor, V371 Hya, X Mus & V407 Sco.

Some other accomplishments include:

1. Solved the mystery of T CMa which was misidentified on the charts for VY CMa and determined that it was constant [5].
2. Established the EA nature of V871 Ara (previously known as HDE331015) [6].
3. Confirmed the pulsating nature and likely RV class of DI Car [7].
4. Corrected the GCVS elements of the Cepheid variable RY Sco [8].
5. Investigated the neglected carbon star V465 Car (previously known as CD -62 466 or SAO251015) [9].

The above list is not exhaustive.

Peter initially reported his observations to the VSS RASNZ whose database was amalgamated with that of the AAVSO in 2009. Before then Peter was also sending his observations directly to the AAVSO and I recall Janet Mattei remarking to me in 2002 how impressed she was with the quality of Peter's monthly reporting.

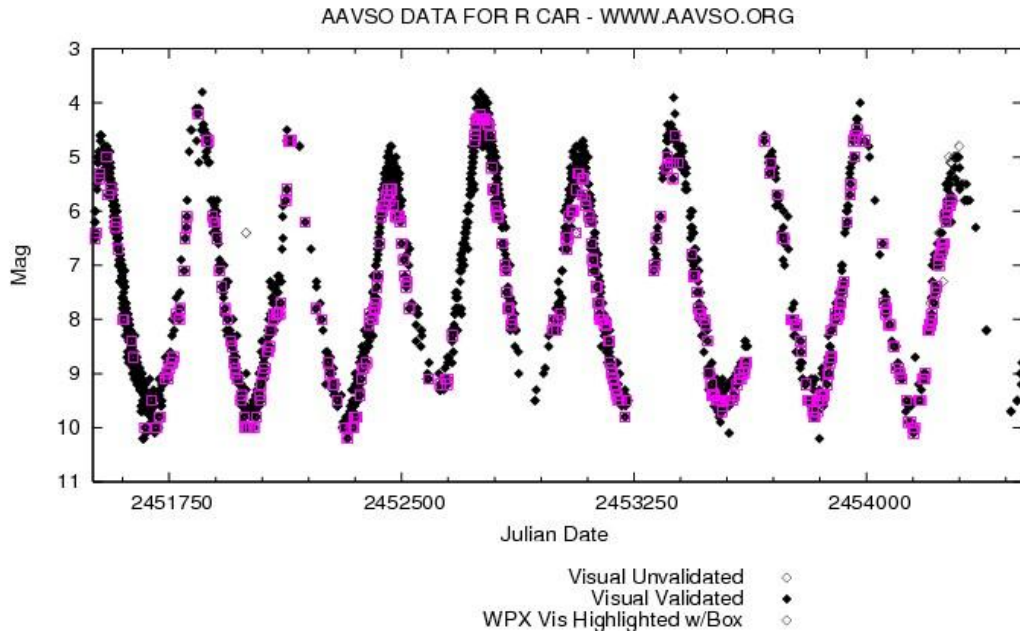


Figure 1: An AAVSO light curve of R Car over a timescale of 3000 days. Peter Williams observations are highlighted and provide a good example of Peter's significant contribution to southern variable star light curves.

During his observing career Peter has discovered by visual means two classical novae and a comet:

Comet C/1998P1 (Williams) was discovered on 10<sup>th</sup> August 1998 in Circinus at magnitude 9.5 when Peter was directing his 30cm reflector (Figure 2) towards the field of EK TrA [10].



Figure 2: Peter Williams with his 30cm F6 Newtonian Reflector that was used for the bulk of his telescopic observations of variable stars and also for the discoveries of Comet C/1998P1 and V2576 Oph (photo taken in April 2006).

Nova Vel 1999 (V382 Vel) was discovered on 22<sup>nd</sup> May 1999 at magnitude 3.1 whilst Peter was undertaking a naked eye nova search ahead of an observing session. This fast nova became the brightest seen since V1500 Cyg in 1975 [11].

Nova Oph No 2 2006 (V2576 Oph) was discovered on 6<sup>th</sup> April 2006 at magnitude 10.5 whilst undertaking an observation of V517 Oph. It is rare for a nova to be discovered at such a faint level by visual means [12].

Peter also received a number of notable awards for his visual work, including:

1996: The Berenice Page Medal from the Astronomical Society of Australia

1999 & 2006: Nova/Supernova Award from the AAVSO

2007: Amateur Achievement Award of the Astronomical Society of the Pacific

From a personal point of view, I first met Peter at the South Pacific Star Party at Wiruna, NSW, Australia in March 1999 [13]. This event was slotted between his comet and first nova discoveries. Peter gave me amended values for some of the comparison stars on certain RASNZ charts that Frank Bateson had sent to me and I realised instantly that we had remarkably similar observing programmes but from opposite sides of the World.

A friendship quickly developed and we further met together with our wives Linda & Irene in Sydney in November 2004 [14] and then in London in August 2013 [15] & May 2019.

Off the back of the 2004 meeting we agreed to co-author a book project on the subject of Visual Photometry of Variable Stars. Such books in the past tended to have either a northern or southern bias and our plan through joint efforts was to provide a balanced coverage of the entire sky. The core of the book would be descriptions, light curves & charts of 200 variables; Peter would cover 100 southern hemisphere stars and I would do the same for 100 northern hemisphere stars. Due to time constraints, I said that the project could not be completed before my retirement (some twenty years in the future) in order to give it the attention it deserved. Peter was prepared to wait and commented that it meant we would have by then some light curves up to 50 years in length. However, Peter could not resist making a start on the project by compiling a draft list of 200 stars and text covering those stars short-listed within the constellations of Andromeda to Auriga. Peter's draft preface wording as co-author is reproduced below:

*During many years involvement in astronomy I have spent much of that time obtaining routine brightness estimates of a diverse group of variable stars.*

*The early years saw a more varied program of observation that included lunar and planetary, comets, meteors, occultations and deep sky. Observation of our very own variable star, the Sun, was also carried out on a regular basis.*

*As a 14-year-old student, I watched in wonder at the Apollo lunar landing missions, a time when artificial earth satellites were still somewhat of a novelty. Today, however, there seems to be such a profusion of satellites and other 'space junk' to make an appearance on many of the night sky photographs taken by amateur and professional astronomers alike.*

*Astrophotography and imaging is one area I have never been seriously involved. A lack of suitable equipment has never allowed for this as my few astro photographs testify.*

*This has, however, in no way hindered enjoyment of the night sky and merely serves to demonstrate a great deal of pleasure - and some useful science - can be achieved without the necessity of owning the latest in telescope and electronic wizardry.*

*Most of my observing has been carried out from suburban locations. This was initially from my parent's home and later from my own backyard at Heathcote on the southern outskirts of Sydney, Australia's largest city.*

*Neither of these locations could be described as perfectly suited for astronomical observation. Sky glow, atmospheric pollution and neighbourhood lights all conspire to detract from the quality of an observing site. They should, however, not be viewed as prohibitive to observation and each of us should take each and every opportunity which presents itself to observe the night sky.*

*Each observing site represents a compromise between convenience and ideal conditions.*

*The night sky is there for us all to enjoy. It is a sad person who has not taken the opportunity to gaze in wonder at the universe in which we occupy a rather small and humble place.*

*This book is intended for those who already have a basic understanding of the night sky and have at least some experience of observing through binoculars and/or a telescope. A general readership is, however, not excluded and it is hoped this may entice those with a curious mind into the fascinating science of astronomy and the study of variable stars.*

The above words date from 2005 and I bitterly regret not having had the time available to undertake and complete this project jointly with Peter.

Peter was frequently my go-to for anything related to far-south variables. He was a major force within the VSS RASNZ working closely with Frank Bateson (Figure 3), Albert Jones & Mati Morel [16]; and he had copies of many of the VSS RASNZ publications that are not yet available in electronic format. We corresponded regularly mostly on astronomical matters but also on a wider range of topics, here are some brief exchanges:

***Australia 1986 [email 24/03/2025]***

*Looking at the dates you were at Ayres Rock for Halley's Comet; I was there for 2 weeks from about 15 April and which included the total lunar eclipse towards the end of April. It was during the eclipse that the tail was evident to an amazing 28 degrees long, as recorded in the International Halley Watch amateur observation archive. Perhaps we passed each other in the dark of the night, but I suspect you may have departed prior to the moon becoming too bright!*

***My response [email 31/03/2025]***

*Back in 1986 I was at Ayers Rock on the 13th & 14th April, Alice Springs on the 15th, Tennant Creek on the 16th, Katherine Gorge on the 17th and then up to Darwin for a couple of nights before flying home. The moon was at first quarter by the time I got to Darwin and I thought the best of Halley was over. I was at a campsite near Ayers Rock but stayed in a motel in Alice Springs. I remember observing with the C8 from the Todd Riverbed (it was completely dry) due to the light pollution in Alice Springs. So, it seems we narrowly missed each other that year.*

***Visual Photometry [BAA VSS Alert 08/07/2014 titled FY Lib]***

*Regarding small amplitude variations, I am not sure if I would like to claim less than 0.1 magnitude accuracy. I make no systematic corrections for colour or star relative to reported V magnitudes when reporting my derived magnitudes estimates. I simply report what I see and, as a visual observer, I know there will always be discrepancies. Many years ago, when a professional analysed*

observations of V854 Cen at maximum it was indicated that some visual observers were resolving variations in the order of 0.05 magnitude - but that was a long time ago. I think it very much depends on a number of factors such as the comparison's location relative to the variable and magnitude difference of comparison stars, star colours and each observer's colour response. Without looking too deeply into this, I understand that I record magnitudes systematically fainter than do many others but more importantly I hope they are internally consistent. In cases where the variable is at a brightness between comparisons of 0.3 magnitude difference, I am sure most observers would have experienced the case where the variable appears only marginally less than the brighter star but are "forced" to record a difference of 0.1 (or no difference at all) simply because the star is not at one third difference but somewhere between.

### **RCB Declines [email 29/10/2022]**

Regarding RY Sgr and the decline onset of the onset of declines, I understand the relationship between pulsation phase and decline onset has been pretty well established going back as far as 1977 when the idea was first suggested (see IBVS1277). This was later supported through observations of V854 Cen and to several other stars. Attached here is a copy of IBVS1277 plus another more recent 2007 paper that talks about decline onsets of other southern RCB stars. The basic idea is that decline onsets are linked to phase 0.5, which is the minimum light of the pulsation and instead of the star recovering back to maximum it just keeps on fading. Maximum light in the pulsation cycle coincides with the star contracting (normal stellar pulsation theory) and if sufficient "soot" is dredged up as the star then expands, then an RCB obscuration event can occur.

The problem with so many of the RCB stars is, however, they have very poorly expressed pulsations and often multiple or "wandering" periods. This makes it hard to link decline onset to a long-lasting period.

The decline onset correlation has been made based largely on long term visual data so, as you note, there is still a role for the visual observer in both monitoring these stars and in providing alerts of current decline onsets.

### **Ancestry [email 29/10/2022]**

On the Williams side, the local family historian (a niece of my father) had the history back to England in the 1700s. But there does not seem to be the great stories as with Linda's family or they have just not been investigated yet. My great grandfather (my dad's father Richard Williams) & wife moved from England to New Zealand before moving across to Australia but there appears to be no record of which ship they sailed on from New Zealand (Lyttelton/Christchurch?) to Sydney so perhaps I am descendant from illegal immigrants – who knows!

Following Peter's passing many in the astronomical community paid fitting tributes including Alfredo Glez-Herrera, Colin Henshaw, Eddy Muyliaert, Andrew Pearce, Rod Stubbings & Elizabeth Waagon. Also, condolences were offered by the Directors of the BAA VSS and AAVSO. I attended Peter's funeral on 16<sup>th</sup> March 2026 online; there were well over 100 people present and the service music commenced with Imagine (Lennon) and concluded with Let It Be (McCartney); Peter was very much a fan of the Beatles.

### **References:**

[1] 2005 BAAVC 124 4

[2] 2021 BAAVC 189 8

[3] Email Williams/Toone 29/10/2022

- [4] [https://www.variablestarssouth.org/vss-newsletter-february-2025/nl\\_2025-1.pdf](https://www.variablestarssouth.org/vss-newsletter-february-2025/nl_2025-1.pdf)
- [5] 2006 JAVSO 34 235
- [6] 2002 PVSS 25 1
- [7] 2006 JAVSO 34 151
- [8] 2002 PVSS 25 28
- [9] 2009 BAAVC 141 29
- [10] <https://www.assa.org.au/resources/variable-stars/accidental-comet-discoveries-by-variable-observers/>
- [11] 1999 BAAVC 101 4
- [12] 2006 BAAVC 128 6
- [13] 1999 BAAVC 102 15
- [14] 2005 BAAVC 123 6
- [15] 2013 BAAVC 158 11
- [16] 2012 JAVSO 40 168

# Eclipsing Binary News

Des Loughney

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

---

## OGLE Atlas of Variable Light Curves

< [https://ogle.astrouw.edu.pl/atlas/eclipsing\\_binaries.html](https://ogle.astrouw.edu.pl/atlas/eclipsing_binaries.html) >

I was looking at the OGLE (Orbital Gravitational Lensing Experiment) website and the section on Eclipsing Binaries. The section claims that it has gathered data on over half a million eclipsing binary systems. It has a telescope in Chile.

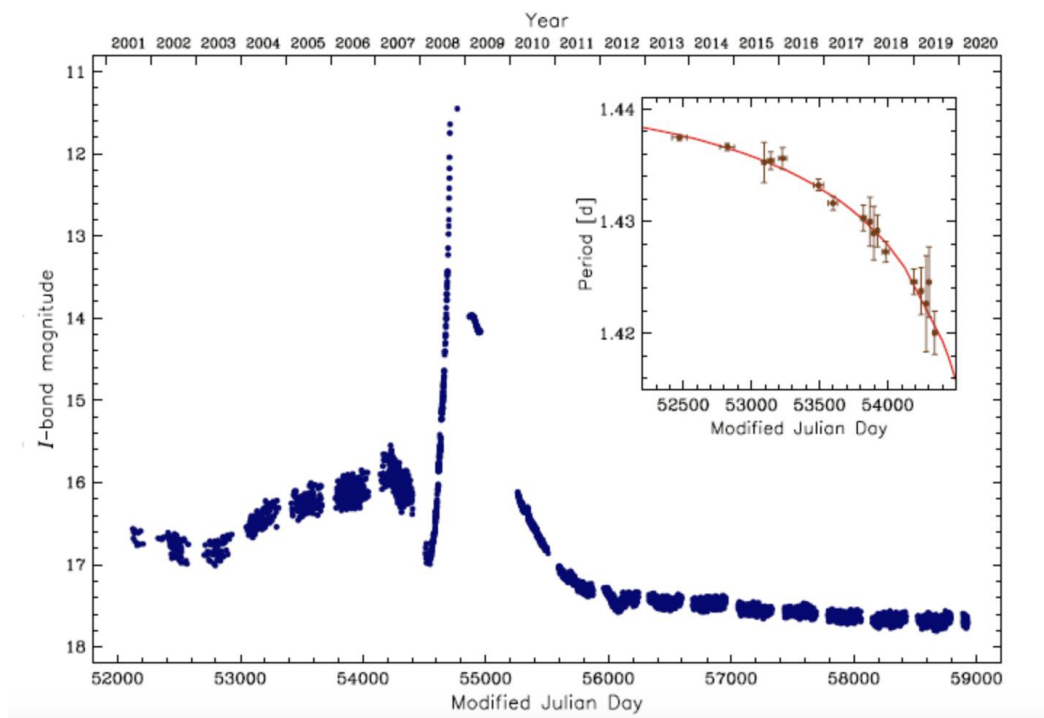
The website presents the light curves of some unusual systems and light curves of the three major classes. It is noted that the light curves of the Algol class have been divided into sub-classes. The sub-classes are binaries with eccentric orbits, and, very interestingly, a sub-class demonstrating apsidal motion. The text on this sub class points out that the effect can only be seen after a decade of photometric monitoring conducted by the OGLE-IV survey. One eclipse is precisely phased while the other is 'blurred.' Further sub-classes were light curves demonstrating the reflection effect and the effect of accretion disks. Another sub-class was new to me, and it is called 'Double Periodic Variables.' The discovery of this sub-class followed analysis of OGLE light curves of systems in the Magellanic Clouds. The longer cycle (up to 1100 days) is thought to be due to magnetic effects in the donor star in a system where there is active mass transfer.

The Beta Lyrae class has a sub class demonstrating the O'Connell effect.

Under the section on the W Ursa Majoris class a specific system is highlighted.

## V1309 Scorpii - "Rosetta Stone for Stellar Mergers"

Fortunately, this system had been monitored by OGLE for a period of seven years as a W U Ma class of eclipsing binary with a magnitude of around sixteen. In 2008 it underwent an outburst when its brightness increased by about ten magnitudes. The event was classified as a 'red nova.' After the event, the system was no longer an eclipsing binary. See the diagram below which illustrates the OGLE data and light curve for the period 2001-2020



An analysis of the OGLE data in 2011 concluded that the event was an actual example of a stellar merger. In Wikipedia there is some information on 'Luminous Red Novae' of which V1309 Scorpii and V838 Mon are examples. They are classified as a type of 'intermediate luminosity optical transient' in between a supernova (brighter) and a nova (dimmer). It has been predicted, from TESS data, that the contact binary system in Cygnus, KIC 9832227, is due to merge soon.

See: < <https://www.virtualtelescope.eu/2017/01/11/star-merging-in-kic-9832227-a-possible-once-in-a-lifetime-event/>>. When this stellar merger occurs, the brightness may reach magnitude two. The prediction turned out to be faulty, and the stellar merger has yet to occur.

## Eclipsing Binaries and the detection of Exoplanets

### Apsidal Precession

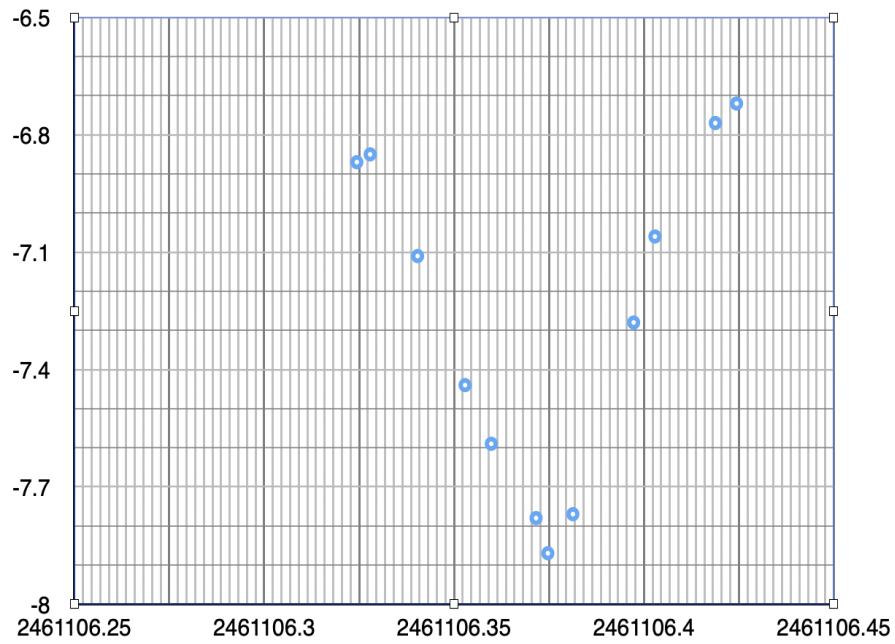
A recent paper [1] has revealed a new use of eclipsing binary data and introduces an aspect of the importance of eclipsing binaries in astronomy.

TESS data has enabled the detection of exoplanets which cannot be seen in transit from the Earth. The TESS data is so accurate that it can detect changes or variations in the period of the binary eclipses caused by the gravitational influence of the exoplanets. The influence has caused orbital precession. An analysis of 1590 eclipsing binaries with at least two years of TESS data has yielded twenty-seven candidate exoplanets. The new worlds range from 12 Earth masses to 10 Jupiter masses.

### RZ Cas Eclipse 6th March 2026

I was able to observe this eclipse and make measurements using DSLR photometry which are illustrated on the diagram below. The predicted mid-eclipse by the Krakow website was HJD 2461106.3912. The observed time of mid eclipse, based on analysis of the data on the diagram, is HJD 2461106.3800. The difference suggests that the observed time of mid eclipse is 16 minutes

early, this result compares with a finding, reported in [VSSC 207](#), of an eclipse on 28/9/26 which was 29 minutes early.



## Reference

1: "Detection of 27 candidate circumbinary planets through apsidal precession of eclipsing binaries observed by TESS", Margo Thornton et al, MNRAS Vol 548, Issue 3, May 2026, stag515,

# More observations of Variable Stars using a Smart Telescope

David Conner

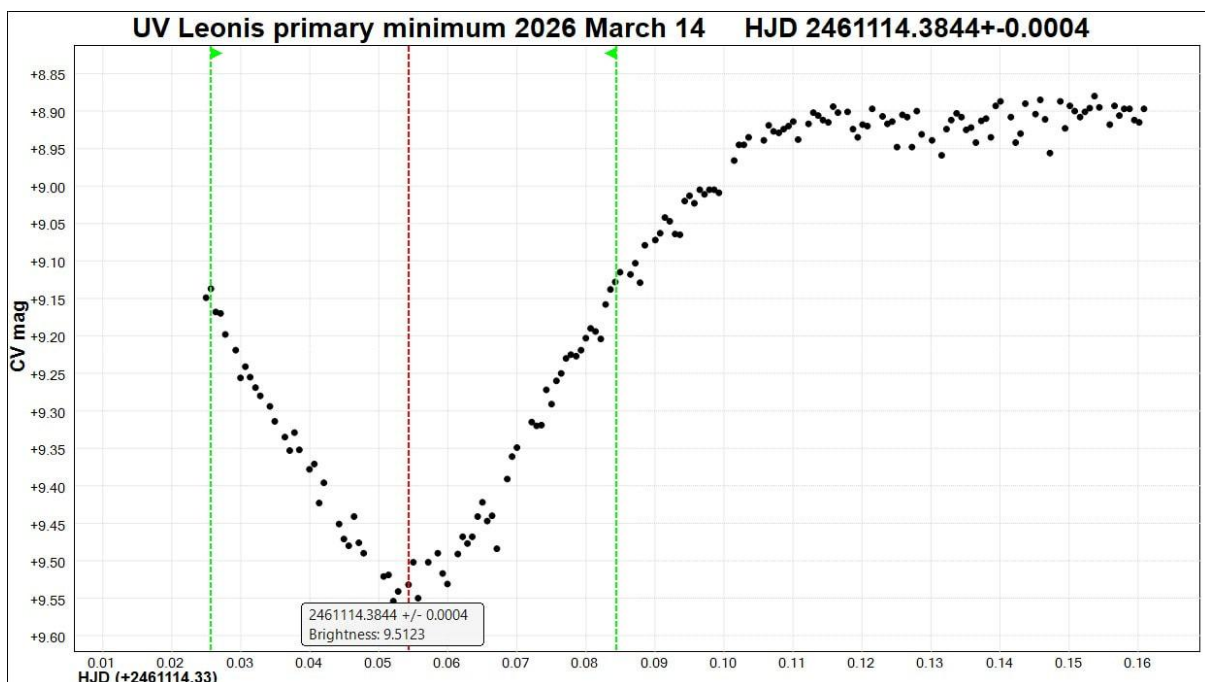
[dsconner100@gmail.com](mailto:dsconner100@gmail.com)

*Further experience of using my recently acquired Seestar S30 smartscope has helped to provide more consistent images for photometry of variable stars, including the timings of minima of eclipsing binaries.*

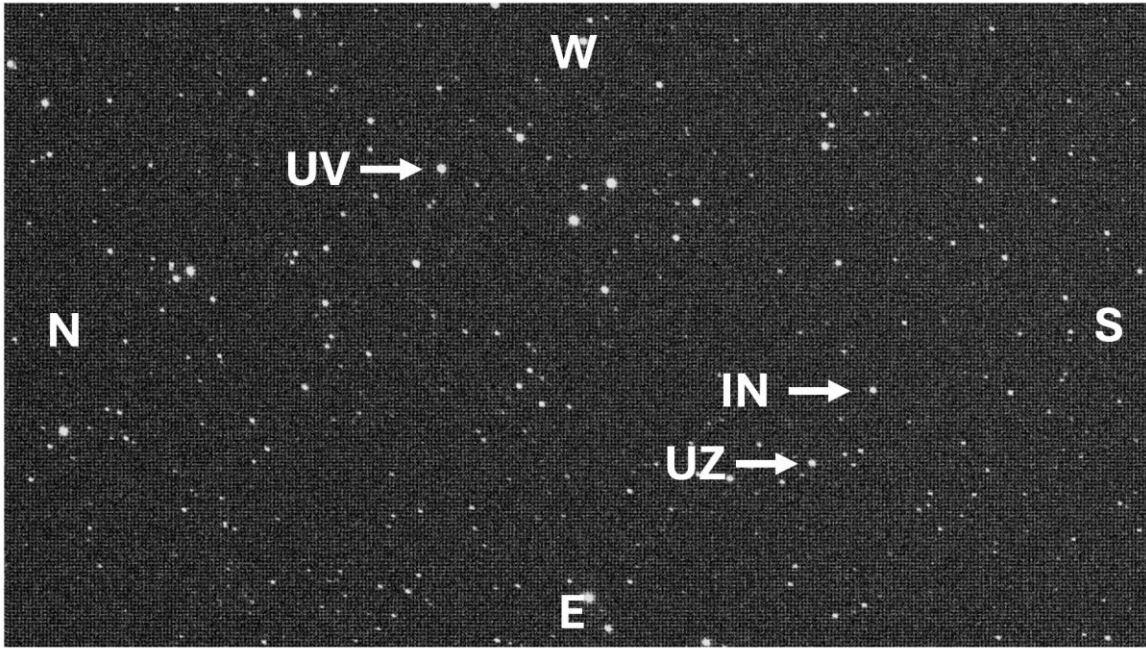
The following observations of variable stars were made with my recently acquired [Seestar S30](#), which was discussed in the previous VSS circular [VSSC 207](#).

They benefit from the previously discussed experiments with focus and dithering, and they also suggest which exposures might be best for which ranges of magnitudes of the variables and comparison stars.

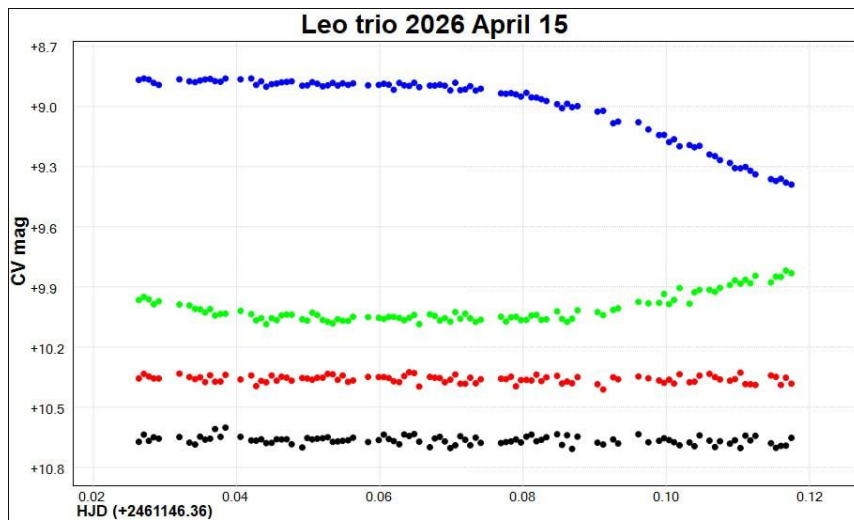
The following primary minimum of the EA type eclipsing binary UV Leonis was the first successful minimum of an eclipsing binary to be observed with this system.



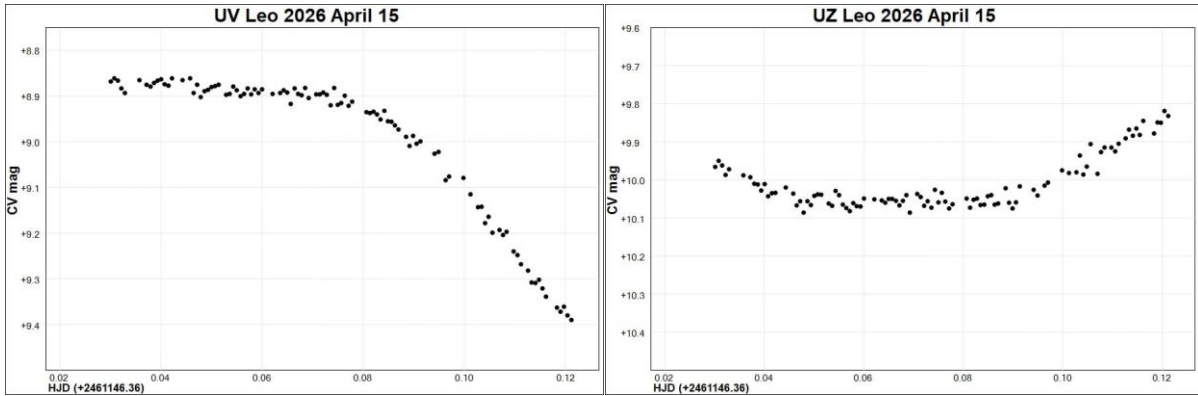
A typical 60s image of the 'Leo trio' follows, with north to the left. UV is an EA type, UZ an EW type and IN an RS type. The camera was in EQ mode. The CMOS sensor is 1,920 by 1,080 pixels, which are visible in the image, and is  $1.2^\circ \times 2.4^\circ$  in size. The FWHM of the stellar images was typically 5 to 5.5, but this varied slightly due partly to slight polar alignment errors, which is the next issue to work on!



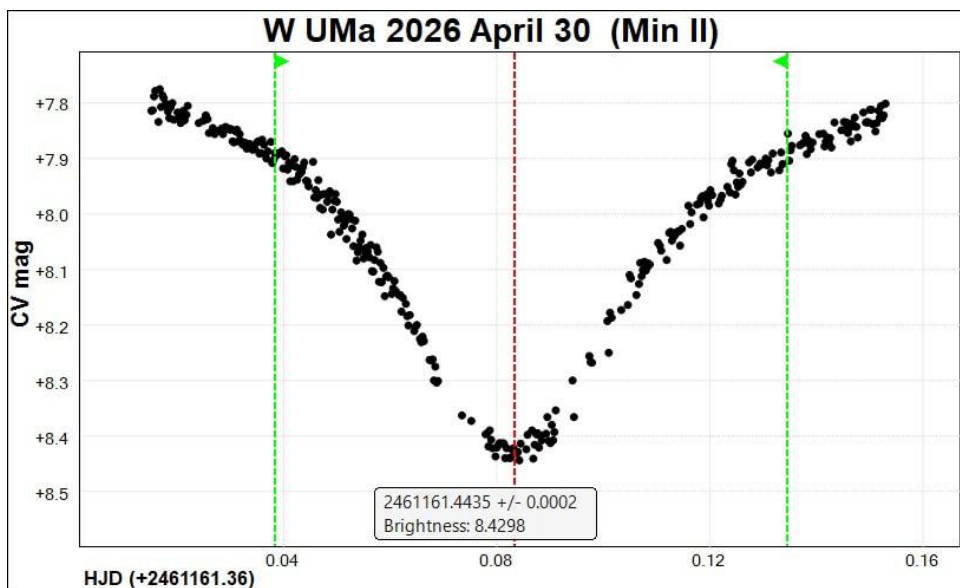
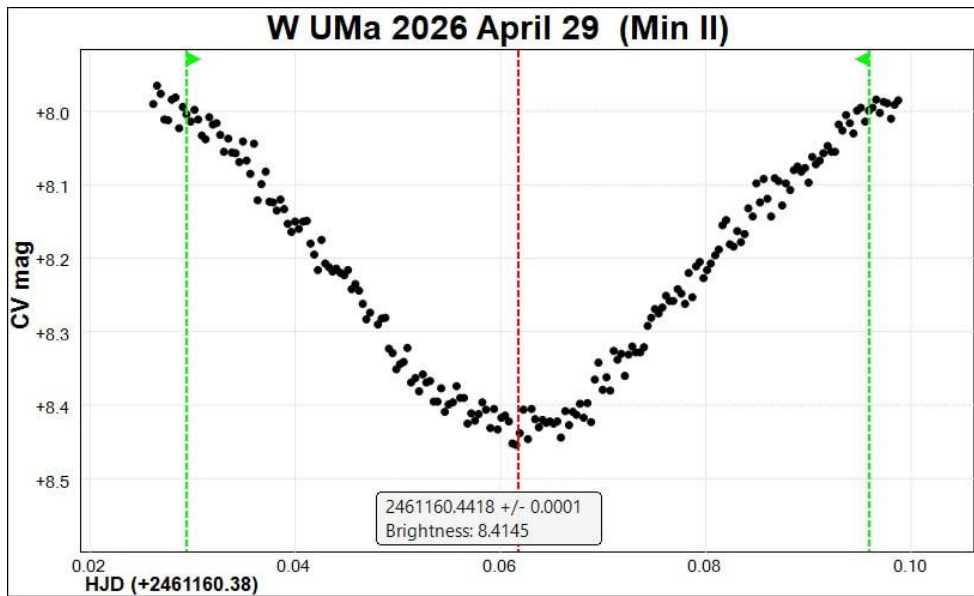
Photometry of these three variables was performed in AIP4WIN, which generated the following light curves – UV in blue, UZ in green, IN in red, and the check-star in black.

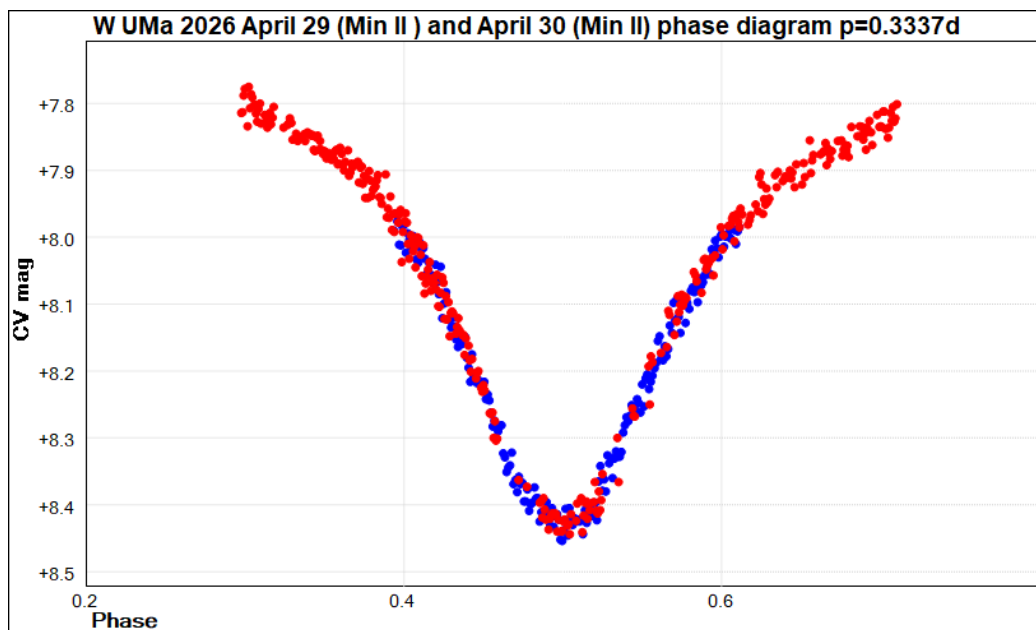
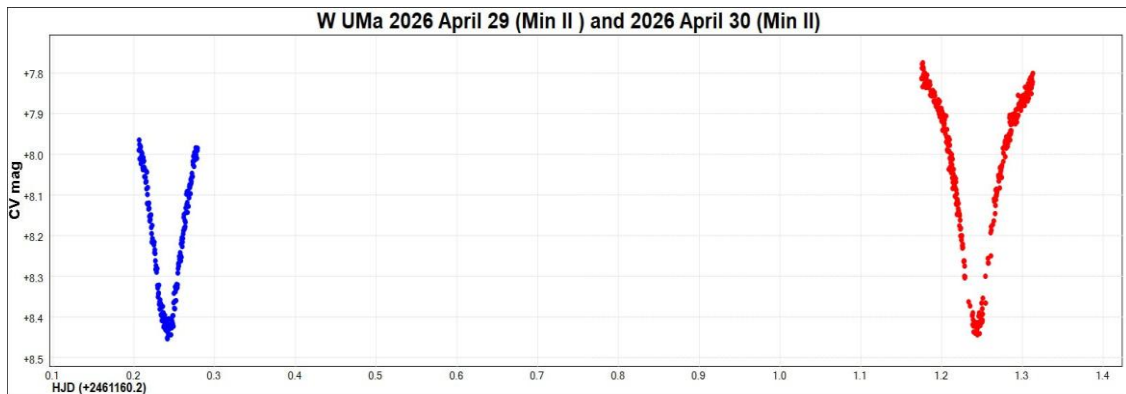


The following enlargements of UV and UZ show how the scatter varies with magnitude, and even for mag 10 the scatter is very approximately within +/- 0.03 mag.



Following this, two secondary minima of the EW type eclipsing binary W Uma were observed on April 29/30 and April 30/May 1, as in the following light curve and phase diagram.





The current period of this system (2026 May 15) is given as 0.33363749d ([GCVS](#)) and 0.3336334d ([AAVSO VSX](#)). There is considerable O-C activity with this system ([Kreiner](#)).

The derived period of W Uma (notwithstanding that this is just a single example which was determined over just 3 cycles) together with the UV Leo primary result, suggest that useful observations of eclipsing binaries can be obtained with this system.

**Times of recent minima of eclipsing binaries observed from [Somerby Observatory](#).**

Photometry was performed in AIP4WIN, and light curves and times of minima were determined using Peranso.

(The data for BX And was obtained from images taken on 2025 October 8 with the 2" Titan at Somerby.)

STAR	HJD of minimum	Filter	Error +/-	Type of minimum
BX And	2460957.3556	CV	0.0006	Secondary
UV Leo	2461114.3844	CV	0.0004	Primary
W UMa	2461160.4418	CV	0.0001	Secondary
W UMa	2461161.4435	CV	0.0002	Secondary

# AP Leonis Minoris is an Algol Type Eclipsing Binary with synchronous RS Canum Venaticorum Light-curve Modifications Superposed

John Greaves

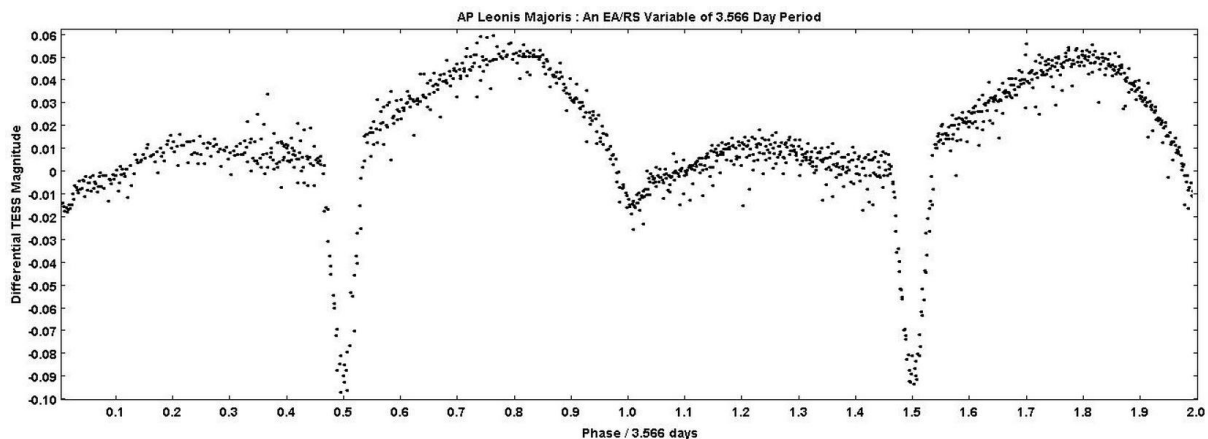
***AP Leonis Minoris (AP LMi) is currently wrongly classified as a suspected BY Draconis variable. Here TESS epoch photometry are used to demonstrate that it is an EA/RS variable with the variability parameters included.***

## Introduction

Data from the MAST server was used in order to access TESS epoch photometry for the variable star AP LMi which is currently classified as an uncertain BY Draconis variable in Khruslov 2010 where it is identified as GSC 3002-01317. The periodicity was tightened relative to the GCVS value, an approximate epoch derived to provide elements for the primary eclipse.

## Results

Figure 1 shows the phase folded light-curve for two cycles of the eclipsing binary for illustrative purposes. It can be seen that it has Algol type eclipses, EA, with both a primary minimum of full about 0.08 of the full rotation period and a much smaller amplitude secondary minimum at phase 0.5 though it tends to be more modified by the RS Canum Venaticorum variable star (RS CVn) signature. The stable repeat of the RS CVn light-curve shows that the rotation period is synchronous with the full orbital period. LAMOST classifies the pair as spectral type G7 whilst eROSITA data shows the pair to be a relatively weak soft xray source, both congruent with the stellar chromospheric activity expected from RS CVn stars.



The full particulars for AP LMi are given here with amplitudes being best guesses due to the mutual interference of the starspot and eclipsing variations :

Minimum I amplitude	0.10 magnitude
Minimum II amplitude	0.02 magnitude
RS CVn amplitude	0.05 magnitude
Min II – Min I	$\phi$ 0.5 = half of full eclipsing period
Period	3.566 days
Epoch	HJD 2458869.3

## **Conclusion**

The variable star AP Leonis Minoris is an EA/RS type variable and not a BY Draconis variable.

## **Acknowledgments**

TOPCAT; MAST; TESS; GCVS; LAMOST dr11; eROSITA dr1

## **Reference**

Khruslov, A. V., "New Periodic Variables", 10, 6, 2010

## Section Publications

---

Hard Copy Charts	Order From	Charge
Telescopic	Chart Secretary	Free
Binocular	Chart Secretary	Free
Eclipsing Binary	Chart Secretary	Free
Observation Report Forms	Director/Red Star Co-ordinator	Free
Chart Catalogue	Director	Free
Binocular VS charts Vol 2	Director or BAA Office	Free

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

---

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 August 15<sup>th</sup> 2026**

---

BAA [www.britastro.org](http://www.britastro.org)

BAAVSS [www.britastro.org/vss](http://www.britastro.org/vss)

BAAVSS Database <https://www.britastro.org/photdb/>

BAA Spectroscopic Database <https://britastro.org/specdb/>

BAAVSS *Circular* Archive [http://www.britastro.org/vss/VSSC\\_archive.htm](http://www.britastro.org/vss/VSSC_archive.htm)

## Section Officers

---



### **Director**

Prof. Jeremy Shears  
Pemberton, School Lane, Tarporley, Cheshire CW6 9NR  
Tel: 07795 223869 E-mail [bunburyobservatory@hotmail.com](mailto:bunburyobservatory@hotmail.com)



### **Assistant Director, CV's & Eruptive Stars Co-ordinator, Circulars Editor & Webmaster**

Gary Poyner  
67 Ellerton Road, Kingstanding, Birmingham B44 0QE  
Tel: 07876 077855 E-mail [garypoyner@gmail.com](mailto:garypoyner@gmail.com)



### **Secretary**

Bob C. Dryden  
21 Cross Road, Cholsey, Oxon OX10 9PE  
Tel: 01491 201620 E-mail [visual.variables@britastro.org](mailto:visual.variables@britastro.org)



### **Chart Secretary**

John Toone  
Hillside View, 17 Ashdale Road, Cressage, Shrewsbury SY5 6DT  
Tel: 07495 330255 E-mail [enootnhoj@btinternet.com](mailto:enootnhoj@btinternet.com)



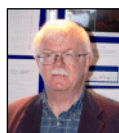
### **Pulsating Stars Co-ordinator**

Shaun Albrighton  
4 Walnut Close, Hartshill, Nuneaton, Warwickshire CV10 0XH  
Tel: 02476 397183 E-mail [shaunalbrighton93@gmail.com](mailto:shaunalbrighton93@gmail.com)



### **Nova/Supernova Secretary**

Guy Hurst BEM  
16 Westminster Close, Basingstoke, Hants RG22 4PP  
Tel: 01256 471074 E-mail [guy@tahq.org.uk](mailto:guy@tahq.org.uk)



### **Eclipsing Binary Secretary**

Des Loughney  
113 Kingsknowe Road North, Edinburgh EH14 2DQ  
Tel: 0131 477 0817 E-mail [dloughney690@gmail.com](mailto:dloughney690@gmail.com)



### **Database Secretary**

Dr. Andrew Wilson  
Tel: 01934 830683 E-mail [andyjwilson\\_uk@hotmail.com](mailto:andyjwilson_uk@hotmail.com)

**Telephone Alert Numbers** for Nova and Supernova discoveries telephone Denis Buczynski 01862 871187. Variable Star alerts call Gary Poyner or post to [BAAVSS-Alert](#) – **but please make sure that the alert hasn't already been reported.**