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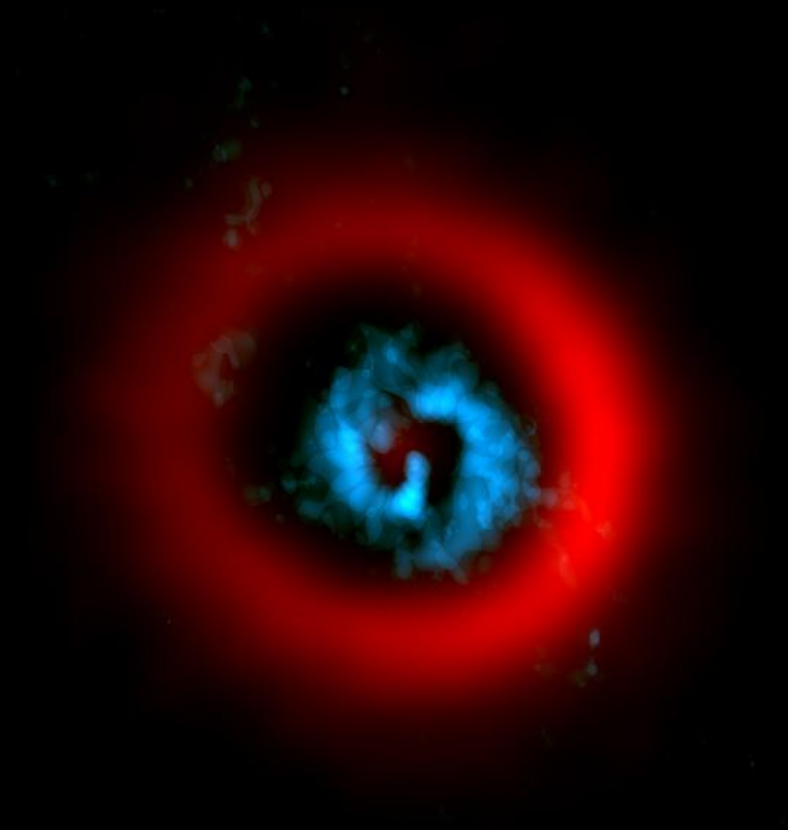
No. 203 March 2025



BAA Office: PO Box 702, Tonbridge TN9 9TX

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Cover Picture

ALMA image of the dust ring and gaseous spirals surrounding the young Herbig Ae star AB Aurigae.

ALMA (ESO/NAOJ/NRAO)/Tang et al. (Press release)

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BAA
VARIABLE STAR SECTION
MEETING

Saturday October 25, 2025

The Humfrey Rooms
10 Castilian Terrace
Northampton, NN1 1LD

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From the Director – *Jeremy Shears*

VSS Meeting on 2025 October 25 and a call for speakers

A VSS meeting with be held on Saturday October 25 at the Humfrey Rooms in Northampton, kindly hosted by the Northamptonshire Natural History Society.

Further details will be provided in due course, including on the VSS website and BAA website https://britastro.org/event/variable-star-section-meeting-2025. In the meantime, please put the date in your diary.

If you would like to speak at the meeting, please do let me know. We would love to hear about your projects, observations and interests in variable stars. Have you made observations of a particular star or been experimenting with a new technique or instrument? Come and tell us about it.

Michael Woodman receives the Charles Butterworth Award for his independent discovery of the 1946 eruption of T CrB

As a 15-year-old schoolboy, Michael Woodman independently discovered the eruption of T CrB in the early hours of 1946 February 9 from his home in Newport, South Wales. So compelling is his story that an interview with him was featured on several BBC news programmes, as well as its website, throughout the day on December 30.

Michael Woodman with the VSS Charles Butterworth Award (photo: Philip Jennings)

Mr Woodman, now 94, was guest of honour at the January BAA meeting in London where I had the enormous pleasure of presenting him the Charles Butterworth Award in recognition of his discovery. He was warmly applauded by the audience in a packed room at the Institute of Physics. Many took the opportunity to have their photo taken with Michael and to chat to him about his discovery. Six members of Michael's family were present for the award.

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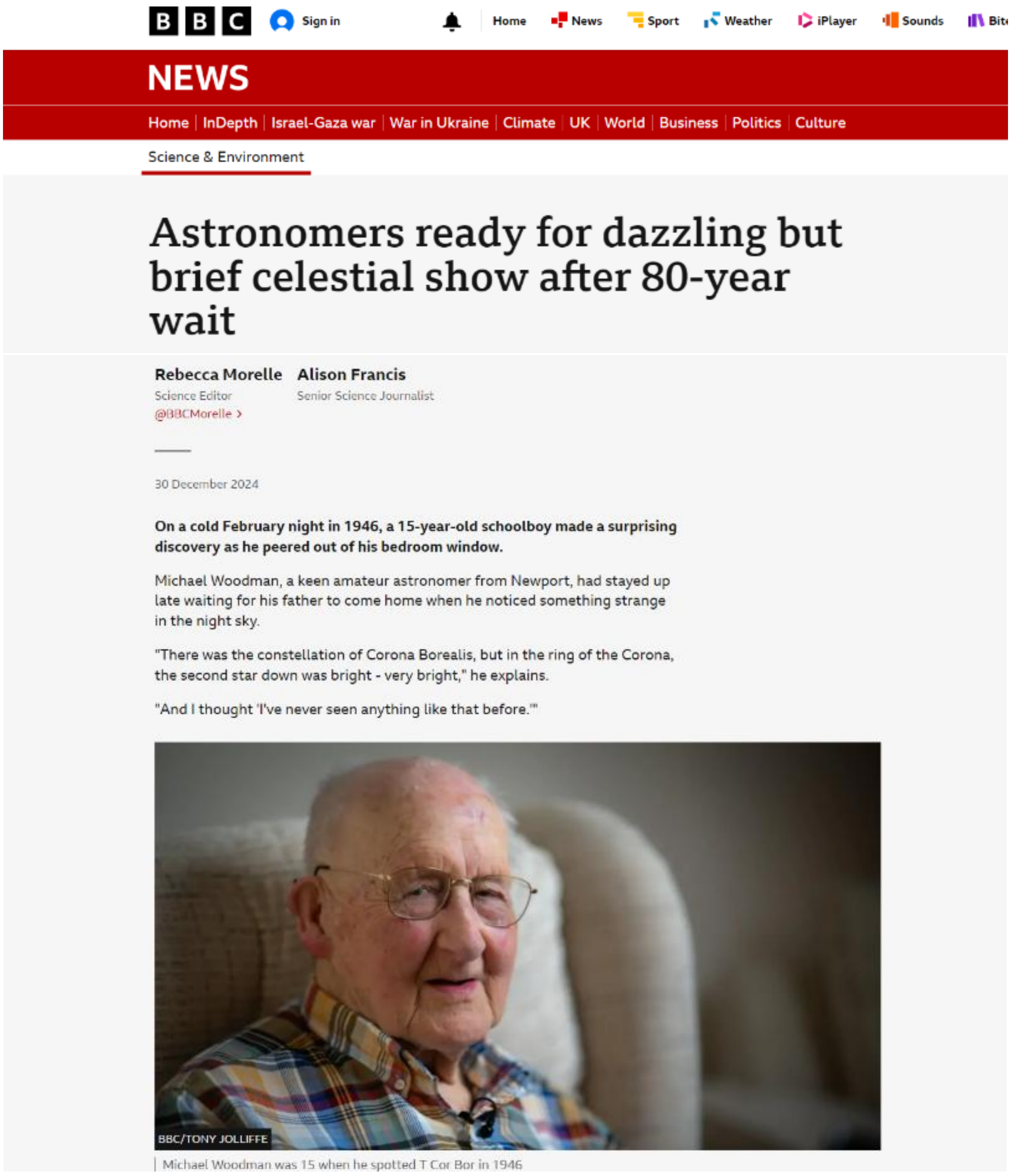
The Charles Butterworth Award was instituted by the VSS in 2004 for outstanding service in the field of Variable Star astronomy. Charles Frederick Butterworth was a Lancashire born amateur astronomer and the first person to complete 100,000 visual variable stars observations, in 1939.

Mr Woodman, who is a BAA Member, recalls his discovery with great clarity. I very much hope that he will soon have the opportunity to witness a second eruption. His sons are primed to take him to an observing site near his East Grinstead home when the eruption occurs.



Astronomers ready for dazzling but brief celestial show after 80-year wait

Rebecca Morelle
Science Editor
@BBCMorelle ›

Alison Francis
Senior Science Journalist

30 December 2024

On a cold February night in 1946, a 15-year-old schoolboy made a surprising discovery as he peered out of his bedroom window.

Michael Woodman, a keen amateur astronomer from Newport, had stayed up late waiting for his father to come home when he noticed something strange in the night sky.

"There was the constellation of Corona Borealis, but in the ring of the Corona, the second star down was bright - very bright," he explains.

"And I thought 'I've never seen anything like that before.'"

Michael Woodman was 15 when he spotted T Cor Bor in 1946

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Michael Woodman flanked by two regular observers of T CrB, John Toone & Gary Poyner

An ancient observation of T CrB?

Professor Graham Shipley, an ancient historian at the University of Leicester with an interest in the history astronomy, has noticed that the 2nd-century BC astronomer Hipparchos is said to have observed a 'new star', which prompted him to compile his great star catalogue. Graham has been looking into the possibility that the star was T CrB, and in a short paper soon to appear in the BAA *Journal,* he presents evidence that the probable periodicity of the variable star, as currently understood, make it likely that an eruption took place during Hipparchos's active career.

W.E. Pennell's photographic atlas of the northern hemisphere

Denis Buczynski recently sent me two A4 folders containing 116 photographs taken by the late Walter Pennell of Lincolnshire. These were part of the late Glyn Marsh's papers and had originally been sent by Pennell to Jim Muirden at *The Astronomer*.

Pennell's project to produce a photographic atlas of the northern hemisphere is described in his BAA obituary: https://britastro.org/wp-content/uploads/sites/W%20Pennell.pdf

The photographs were taken in 1971 on Tri-X film with an exposure of 10 mins. The prints are also beautifully produced. The photos are remarkable for their guiding quality, revealing pinpoint stars, as well as showing how many clear, moonless nights there were. And I can find only three prints with satellite trails!

The atlas covers the region from Dec. -3° to the north celestial pole. The prints cover an area of 21° x 14° with a scale of 1°= 11.5mm, the limiting magnitude is typically 11. A Wratten 8 yellow filter was used throughout. The prints are unbound and each is 24.5 x 17 cm.

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Example print from W.E. Pennell's photographic star atlas

Walter Pennell produced many photographs for the VSS over the years and these in turn were used to produce charts and sequences for use by visual observers. Photovisual photometry was in Pennell's mind when he produced his atlas. His accompanying note says, "Star image diameters are satisfactorily constant for most prints between 3 to 9 mag and estimates to at least .2 mag should be possible". He provides a calibration plot of visual magnitude versus image diameter.

The final sentence of Storm Dunlop's obituary of Walter Pennell says, "His astronomical skills will be evident in his legacy of fine photographs, which, it is hoped, will serve as an inspiration to others". An example print shows the region of M31 taken on 1971 August 25.

If anyone has a project for which Pennell's atlas might be useful, do please contact me. Whether modern photometric techniques could usefully be applied to the prints remains to be seen, in which case scanning the prints might be arranged.

Storm Dunlop (1942 – 2025)

I must convey the very sad news that Storm Dunlop passed away on 2025 January 25. He joined the BAA in 1969, going on to become President in 1986 - 87. He was a great supporter of the VSS over many years, editing our *Circulars* from Dec 1975 (VSSC 24) to Dec 1992 (VSSC 74), and attending VSS meetings.

Storm wrote, and translated, many books on astronomy and weather. For many years he produced the annual Collins *Guide to the Night Sky* with Wil Tirion.

A full obituary will appear in the BAA *Journal* in due course.

Storm Dunlop with other VSS officers at the VSS Centenary Meeting on 19 Oct 1991 (photo by Richard Fleet).

L to R: John Toone, Roger Pickard, John Isles, Melvyn Taylor, Guy Hurst, Storm Dunlop

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An important note from Andy Wilson – Database Secretary

Minor change to digital photometry files sent to the AAVSO

We have received a request to make a very minor change to the format of the digital photometry data files some of our members send to the AAVSO. This will affect observers who use the BAA Photometry Spreadsheet. I have published a new version, which can be downloaded from:

https://britastro.org/vssdb/notes_submissions.php

The change is very simple. Previously the spreadsheet was reporting MTYPE as "ABS", and we have been asked to report it as "STD". This has no effect on the photometry calculation, it just simplifies the backend for the AAVSO, as they were changing "ABS" to "STD" in the files that were submitted.

It would be a good idea for anyone who uses their own spreadsheet or other pipeline to report data to the AAVSO to check what they are submitting in the MTYPE field.

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CV & E News

Gary Poyner

garypoyner@gmail.com

Recent activity in programme objects including January 2025 activity in the Blazar S5 0716+71, the January 2025 outburst of the long period UGSU star QY Per and February dust event fade in the UXOR Herbig Ae star AB Aur are discussed.

S5 0716+71

ATel #16980 (January 15, 2025) reports that the blazar S5 0716+71 has displayed enhanced optical behaviour after several years of ‘weak activity’, with its brightness peak of 12.5 on the January 12-13 2025 – the brightest seen since 2020 (Fig.1). R band photometry reveals increased IDV’s (Intra Day Variation) increasing from 0.1 to almost 0.5 magnitude within a few hours. Past observations made by BAAVSS observers have also recorded IDV’s in S5 0716+71 in the order of 0.1-0.5 magnitudes in its coverage from 1998 to present.

Looking through the BAAVSS database, we see an important gap in the observations for the dates of this increased activity, which proved to be relatively short. Poyner and Toone have a mean value of 13.4mv on January 10 with the next observation made on Jan 15 at 13.2mv – completely missing the bright optical ‘flare’ but recording the object at a relatively brighter state in its aftermath. At the time of writing (Feb 10), the visual magnitude had dropped to its pre-flare value of 13.7-14.0mv.

ATtel #16995 reports the Swift detection of an X-ray flare on Jan 23, 2025. The detection of this X-ray flaring state might indicate that optical brightening could occur again, and observers are asked to continue monitoring as often as possible.

Finder charts are available from the AAVSO Variable Star Plotter using the designation PKS 0716+71

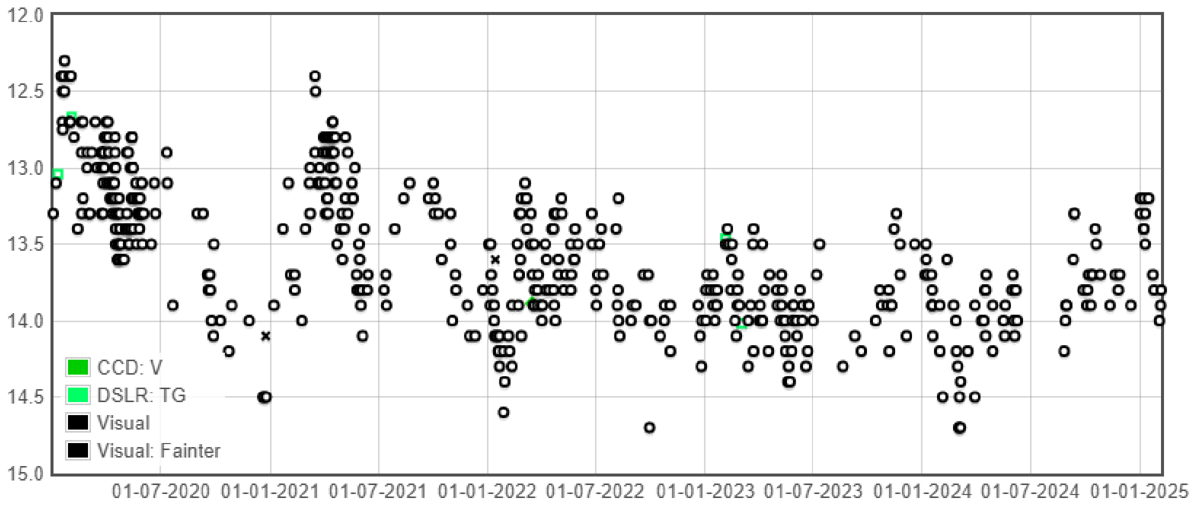

Figure 1: S5 0716+71 2020-2025: C P Jones, M L Joslin, W Parkes, G Poyner, J Toone, T Vale
BAAVSS Database

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QY Per:

The rather rare long period UGSU star QY Per entered outburst on January 27.93 at magnitude 13.89CV, detected by the COAST telescope from an image obtained by G. Poyner (Fig.2). This was the first recorded *confirmed* outburst detected since January 2018. Two solitary positive observations appear in the AAVSO DB on Sep 9, 2019 and Dec 18, 2019. The September data-point has no negative observations fainter then the reported magnitude within eleven days of the observation. The second has a negative observation one magnitude fainter than the reported magnitude, just four days later. One is very probably real, but previous outburst intervals seem to suggest that an outburst occurring within three months of another is unlikely – although not impossible.

The current outburst lasted some 14 days, peaking at the detection magnitude of 13.89CV, suggesting that this was a normal outburst (Fig.3). Coverage was poor, with only 14 observations reported to the VSS database by one observer. The AAVSO DB includes 25 observations from five observers (including the BAAVSS data). There were no time series observations reported.

QY Per was discovered in 1966 by Hoffmeister. A previous outburst was identified in 1964, and further outbursts in 1969 and 1989 (Risino) followed [1] The first visual observation of QY Per in outburst occurred in October 1994 (Vanmunster), since when five outbursts have been confirmed. Nick James provided accurate photometry during the 1994 outburst.

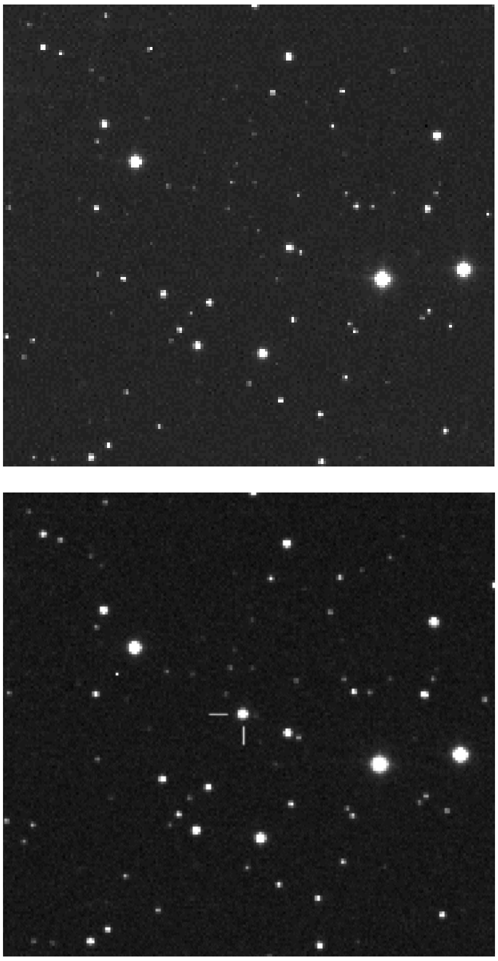

Figure 2: Cropped images from *COAST*

Top: Jan 19.92, 2025 magnitude <17.3CV (*Poyner*)

Bottom: Jan 27.93, 2025 magnitude 13.89CV. (*Poyner*)

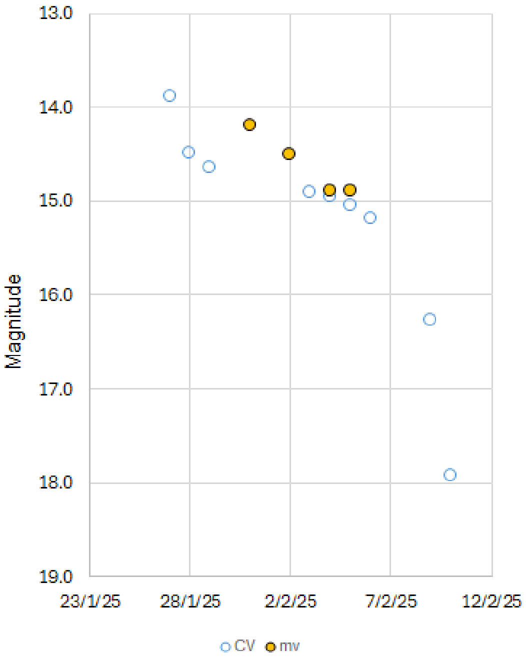

Figure 3. The 2025 outburst. *BAAVSS Database*

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AB Aur:

Several observers have reported to the BAAVSS alert group and/or the BAAVSS database during the first week of February, that the UXOR Herbig Ae star AB Aur is undergoing another dust event fade – the second in just five months.

Following the fade to magnitude 8.1 mean during September 2024, AB Aur failed to reach its mean maximum value of ~7.1mv by at least 0.2 magnitude in its recovery. The first signs of the current fade were observed on February 5.5 UT, when AB Aur had faded to magnitude 7.7 – a 0.3 mag drop in 24h. At the time of writing (Feb 24), AB Aur has returned to it's maximum brightness of 7.1mv.

Figure 4 shows the activity of AB Aur from September 2024 to February 2025. The visual data points above magnitude 7.5 are 5 day means, with single day datapoints for anything fainter.

For a more in-depth description of the AB Aur system, see BAAVSS Circular 180 [2]

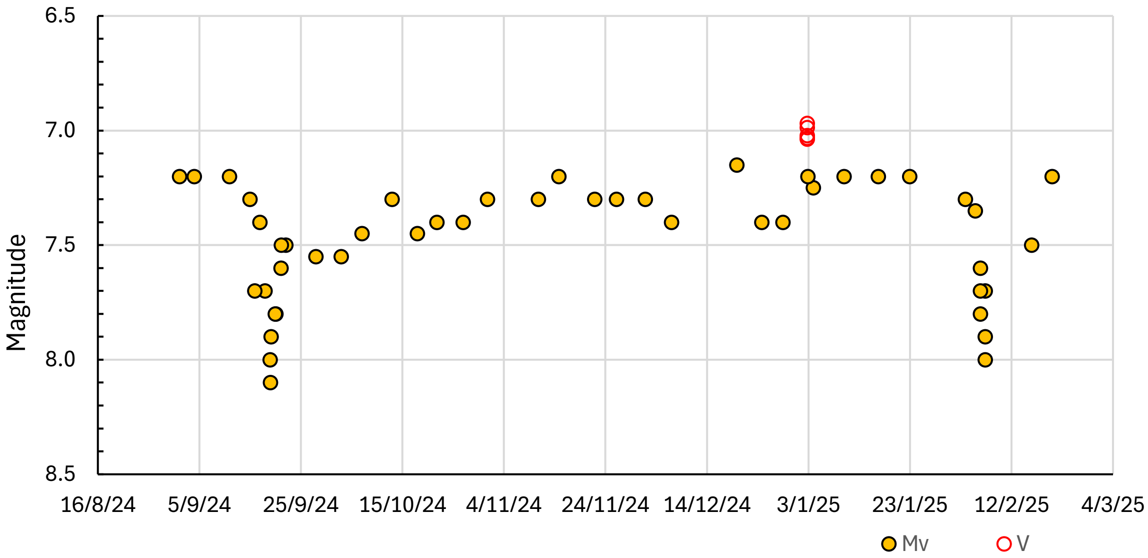

Figure 4. AB Aur September 2024 to February 2025. S W Albrighton, L K Brundle, R Fidrich, G Flemming, R B I Fraser, G Oksa, R Pearce, G Poyner, J Toone, W J Worraker. *BAAVSS database*

References

1. IAUC 4900 Nov 7, 1989.
2. AB Aurigae. John Toone, BAAVSS *Circular* 180, June 2019

Cover image:

ALMA image of the protoplanetary disc surrounding the Herbig Ae star AB Aur. The dusty disc (red) has a radius of ~120AU, and surrounds a gaseous spiral structure (blue), best explained by the presence of an unseen planet. From "Planet Formation in AB Aur: Imaging of the Inner Gaseous Spirals Observed inside the dust cavity. Tang et al. ApJ 840:32, 2017 May 1

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Recent observations of Mira Variables on the BAAVSS programme. 5

Shaun Albrighton

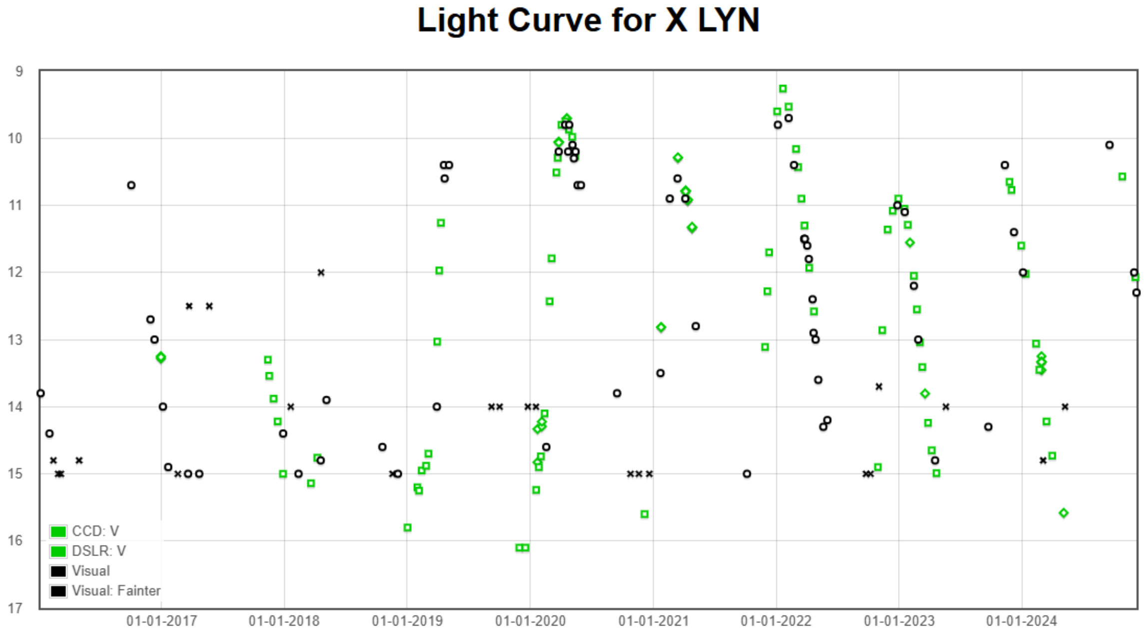
shaunalbrighton93@gmail.com

In this report we examine a further four Mira variables on the BAAVSS programme between 2016 and Dec 2024

X Lyn

VSX lists X Lyn as having a range of 9.5 – 16V, Period 320.8d, the duration of rise are not recorded. The spectral type is M5e.

BAAVSS observations during the review period confirm the extreme range in V Band of between 9.2 and 16.2. What is clearly evident is that the maximum varies between 9.2 and 11.0. Additional observations of X Lyn are requested to help refine not only by how much maximum vary but also the minimum. CCD observations will probably be required for minimum.



Period analysis by Thomas Karlsson (SAAF) [2] (see below) between 1901 and 2022, shows random fluctuations between 318 and 329d. Of note is that the period has been rising from 321d in 2004 to current value of 329d. It will be interesting to see if the period continues to increase or start to fall again.

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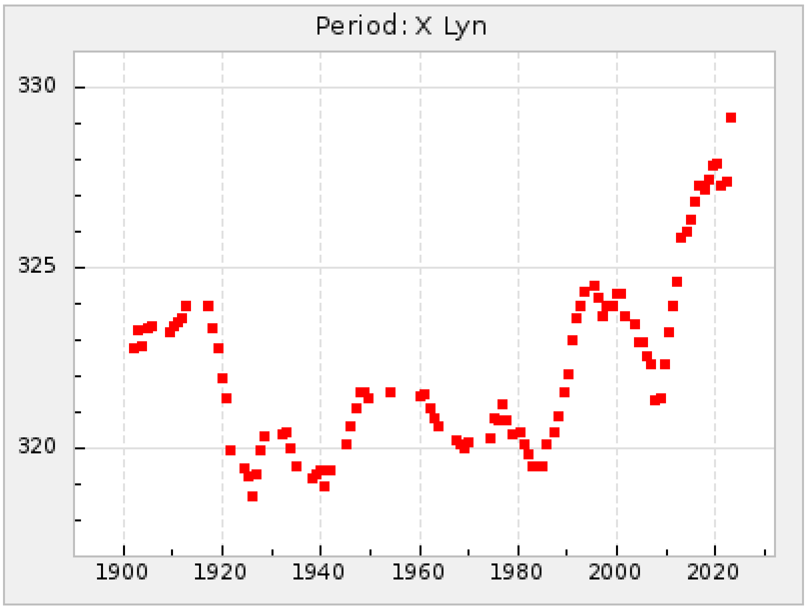
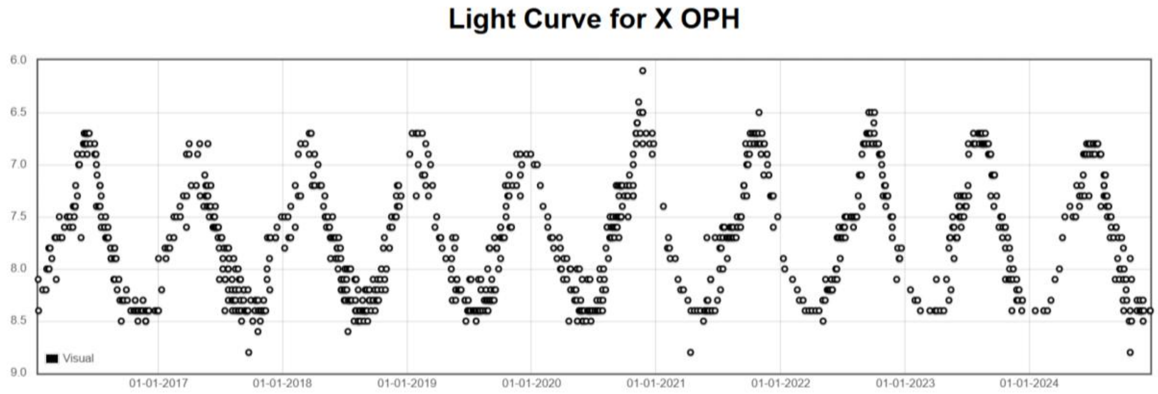


X Oph

X Oph is listed in VSX has having a range of 5.9-8.6V, Spec M5e-M9e, Period 332d, with (unusually) a rise time of slightly over half, being 176d (53%). BAAVSS observations since 2016 give a lower range for maxima of 6.5 to 6.8. Perhaps the most interesting feature of X Oph is the flat minima. This is due to the star having a mag 8.7 companion, which lies 0.5" distant from the Mira variable. This means that the brightness of minima are raised slightly, reducing the amplitude.

Although having a small range (for a Mira), it is rare, in that it can be followed throughout its entire range using binoculars.



As will be seen in the plot below [2], the period for X Oph varies in a cyclical fashion between 326 and 342 days. There is a hint of an approx. 40 year period to this variation.

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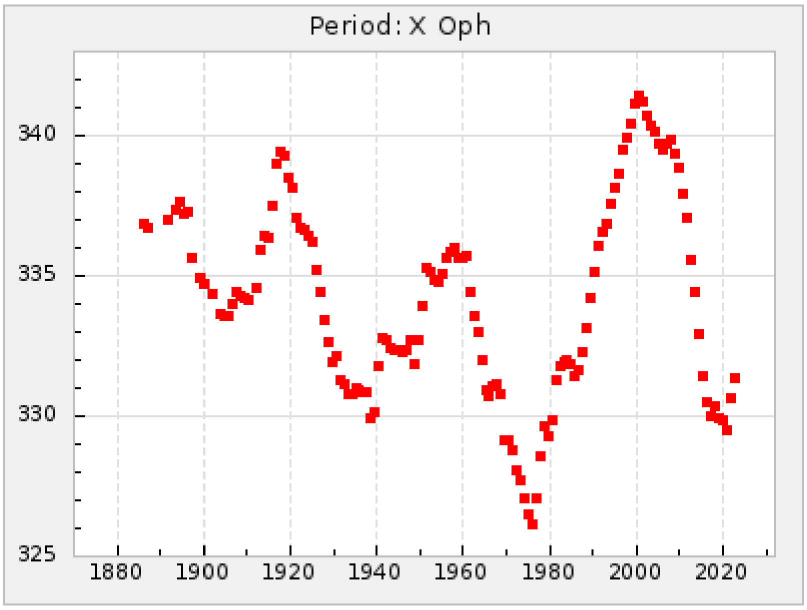
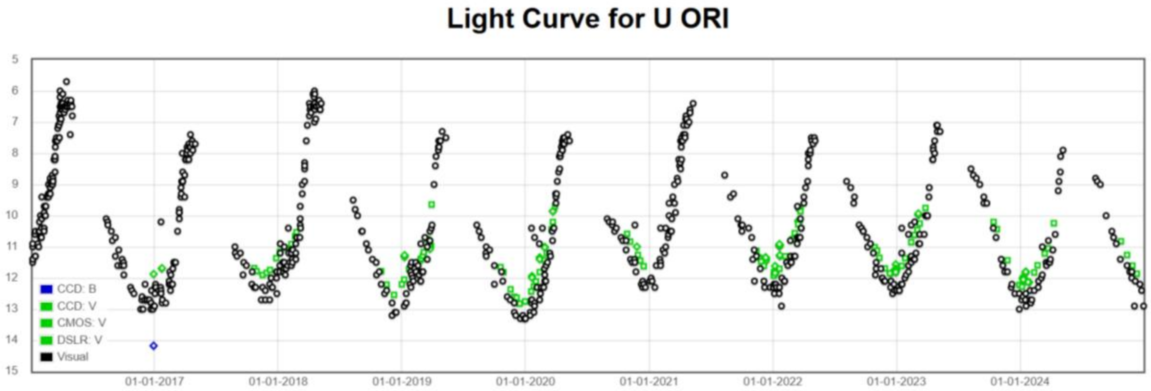


U Ori

VSX lists U Ori as having an extreme range of 4.8 – 13.0V. Spec M6e – M9.5e, Period 371.7d, rise occupies just 141d (38%).

One issue with U Ori is that it lies very close to the ecliptic, so is not observable between mid-May and late Jul. In addition, with a period of close to one year, it will be seen that maxima are currently occurring during this period, so are unobserved. Of note is that U Ori experiences a range of approximately 1.5 magnitudes for maxima and 1.0 magnitudes at minima.



Period analysis [2] shows that between 1885 and 2022, the period for U Ori has varied between 263 and 378 days. One interesting feature is that this variation appears to vary in a cyclical fashion, with a period of between 25 and 30 years.

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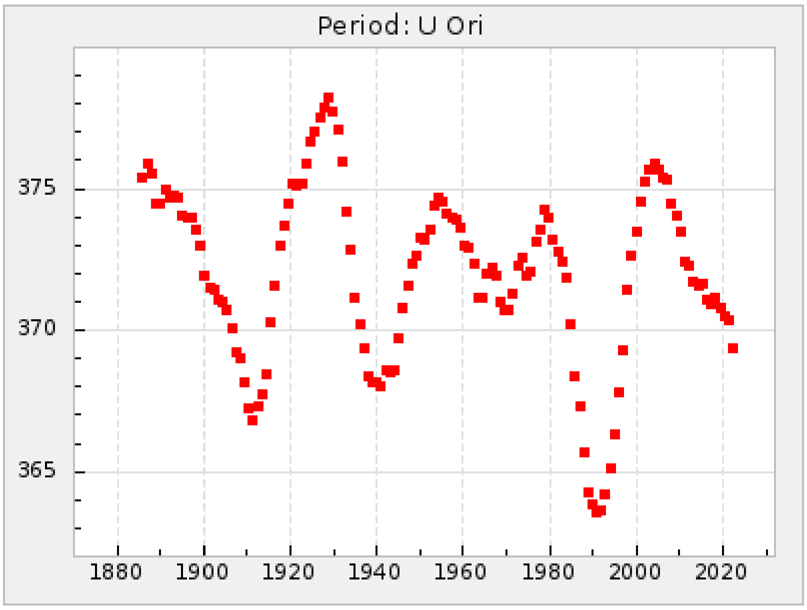
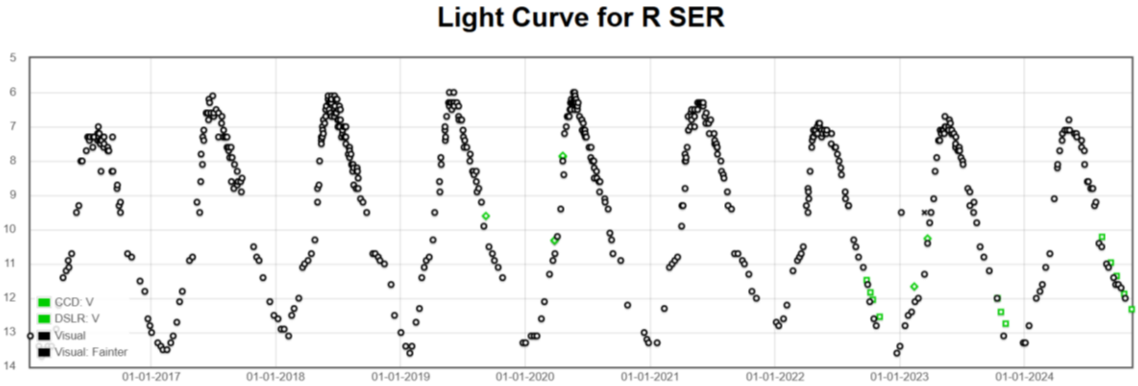


R Ser

VSX lists R Ser as having a range of 5.16 -13.4V, Spec M5IIIe-M9e, Period 355.1d, with the rise taking 41% (146d). Looking at results since 2016, shows that maxima have varied between 6.0 and 7.1. In comparison, minima have varied between 12.9 and 13.8.



Below is a plot of recalculated BAAVSS magnitude estimates for R Ser between 1890 and 2025. This gives an extreme range of between 5.5 and 14.0, fainter at both extremes than the quoted VSX V band range. This demonstrates the value of recording the full magnitude estimate by observers, enabling (where possible) to adjust the resultant magnitude according to the sequence used.

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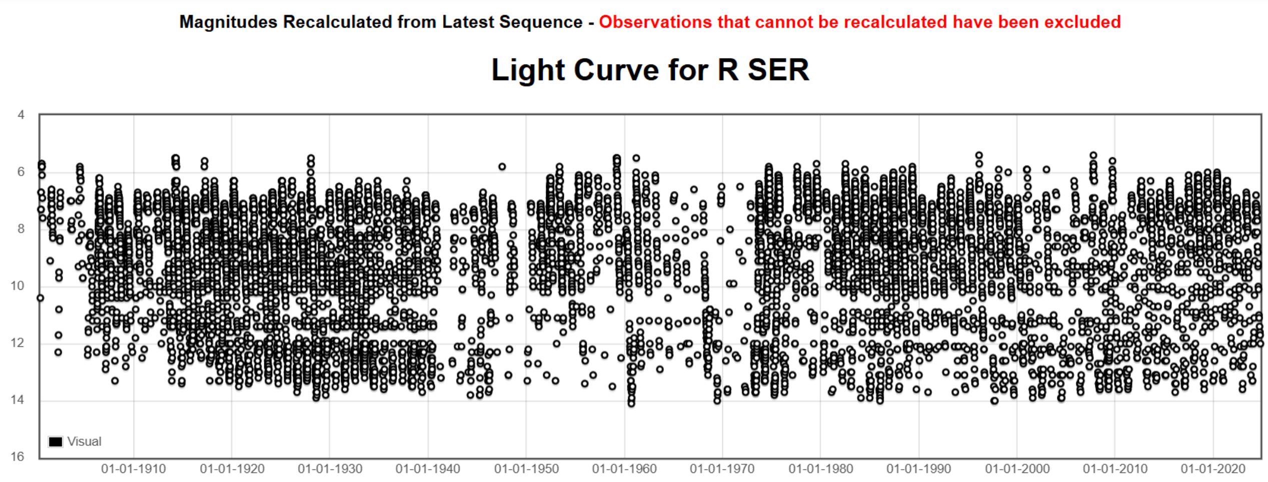
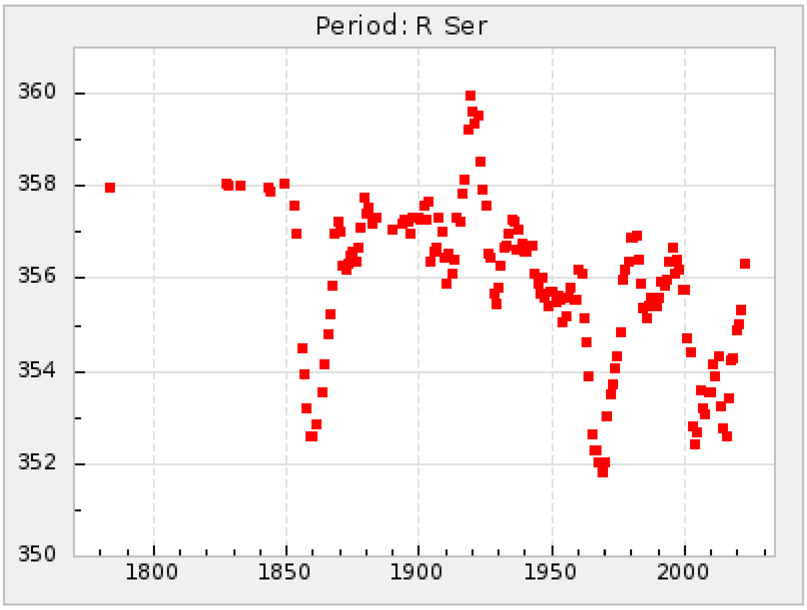


Period analysis [2] shows that the period for R Ser has varied in an erratic manner, between 352 and 360 days.



References

1. All data VSX
2. Period plots by Thomas Karlsson (SAF)

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Is OJ287 switching off?

Mark Kidger

cricketingstargazer@gmail.com

Between 1993 and 2015 the average magnitude of the blazar OJ287 was V=15.17, although there were excursions to both much brighter and much fainter magnitudes during this time. In particular, there were double-peaked outbursts in 1994/95, in 2005/06 and, again, in 2015/2017. Almost as interesting in the historical light curve is the unfortunately not well observed minimum that started in Spring 1998 when, for almost two years, OJ287 was usually fainter than V=16. That deep minimum seems to be repeating, 26 years later. Once again, OJ287 is passing through an unusually deep and long-lasting minimum. What is uncertain is how long it will last and just how deep it will be. As of mid-February 2025, OJ287 is closing on the rarely reached level of V=17 at which point the underlying galaxy starts to reveal itself strongly.

Since reappearing from conjunction in Autumn 2016, OJ287 has faded progressively, at an average rate of 0.00046 magnitudes/day (Figure 1). In October 2016, the average magnitude of this blazar was V=13.68. In contrast, in the first half of February 2025, the average magnitude has been V=16.79.

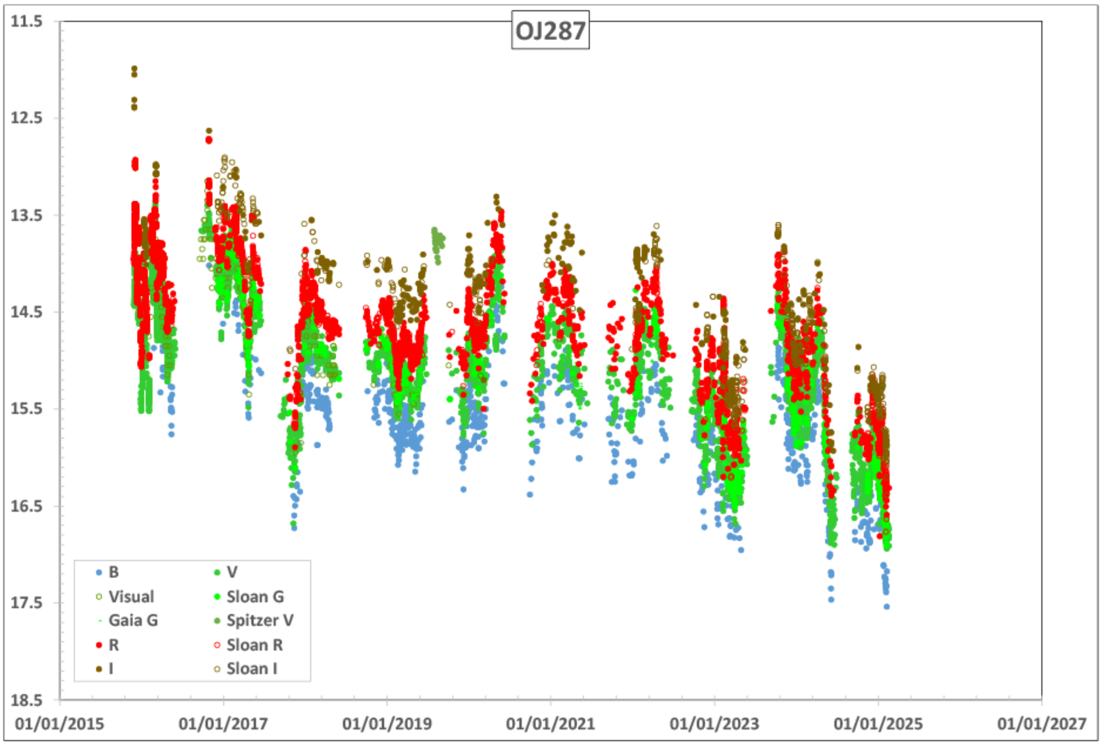

Figure 1. : The light curve of OJ287 in B, V, R & I since Autumn 2015. We can see a clear trend to fainter magnitudes over the last eight years.

In part, this fading trend has been due to a quite unprecedented minimum that has now lasted nine months and, at the time of writing, shows no signs of ending. In late April 2024, a rapid fade of the blazar to unusually faint levels started. What has been remarkable about this fade is not just how deep and persistent it is, but just also how rapidly the blazar faded from 'normal' levels these unusually faint magnitudes.

In less than six weeks the OJ287 dropped from around V=14.8 (in mid-April 2024) to V=16.7 (at the end of May). After a partial recovery during the solar conjunction of 2024, a new, slow fade started in the second week of December 2024. This has led OJ287 to almost unprecedented levels, with it seeming likely that OJ287 will drop below V=17 in the next few weeks.

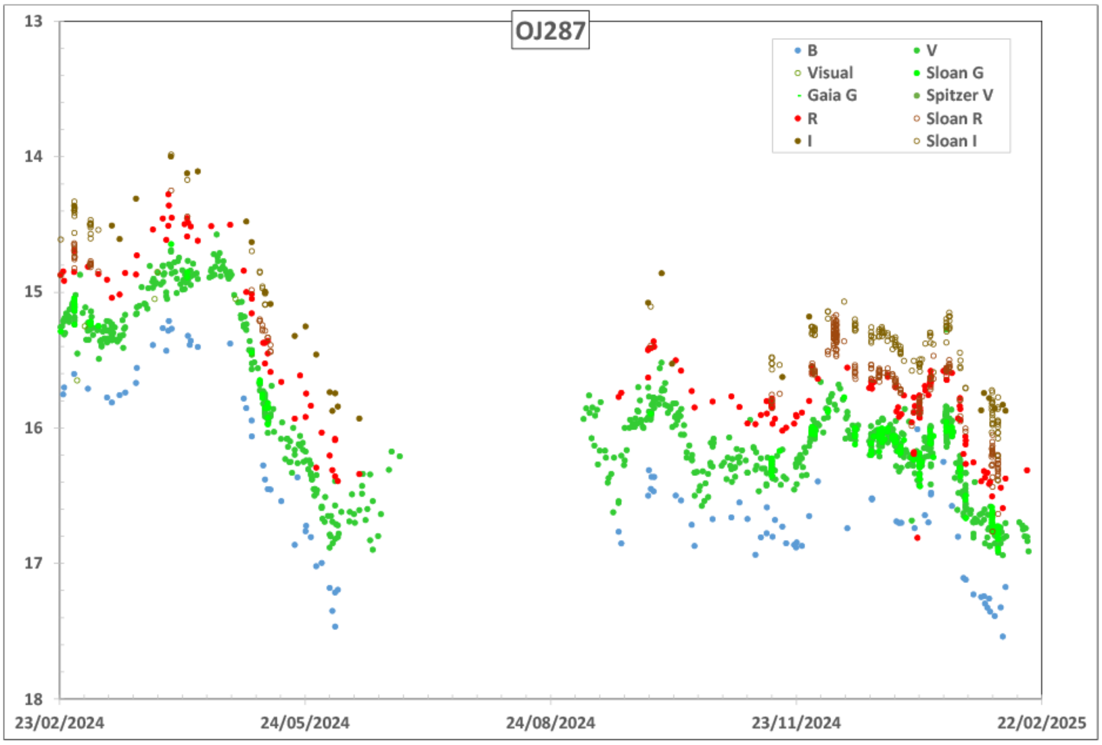

Figure 2. : The light curve of OJ287 in B, V, R & I for the last year. The abrupt fade in Spring 2024 is very evident.

Over the last nine months the overall light curve pattern has, in general, been quite stable. The average magnitude since reaching minimum has been V=16.18. There have been frequent short flares of amplitude around half a magnitude, typical of shocks in the blazar's relativistic jet but, unexpectedly, after each of these flares, instead of recovering, OJ287 has returned to a faint level.

One feature of these flares is counter-intuitive but was noticed as long ago as 1968, in the violently variable quasar, 3C345. Over three years of observations, Kinman et al. (1968) observed a series of regular flares every 80 days [1] What puzzled Kinman and his colleagues (and took decades to explain) was why the flares had almost exactly the same amplitude whatever level of the light curve they started from. We see the same effect in OJ287. The flares of OJ287 are typically of approximately half a magnitude whether the blazar is magnitude 16, or magnitude 13. Intuitively, you would expect the flare to make a bigger net contribution to the light curve when at fainter magnitude, but it does not. Somehow, something in the blazar seeming 'knows' that it should have much more energetic flares when brighter.

Instead, what we find is that these flares are not adding light as such. What they are doing is amplifying the light that is already there. This is due to the lighthouse effect. The shock in the blazar's jet is like a magnifying glass concentrating the light in the direction that it is moving. Depending on how exactly the beam of the shock is pointed towards us we see the light 'flash on' or not. The amplitude of this flash will be independent of the band used for the photometry

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Figure 3. The lighthouse effect. The beam is always present, but we see it brightly only when the beam points in our direction. This is the way that the beam of light from a shock in a blazar's relativistic jet works: when the light is beamed our way by the shock's motion, we see an increase of brightness.

In mid-November 2024 a steady brightening of the quasar started. This appeared to be the start of a rise out of this prolonged minimum. What was unexpected was that this brightening lasted three weeks, reached V=15.8 and then, reversed again. Since then, the trend has been steadily downwards again, albeit with brief flares interrupting the fading trend. However, after each flare the magnitude has been fainter than before the flare started. In the first half of February 2025, both Martin Mobberley (twice) and Esteban Reina (once) have measured magnitudes fainter than 16.9, while Gary Poyner has measured the blazar at 16.89. Despite another brief recovery around the February 2025 Full Moon, the relentless downward trend seems to have started again. It seems inevitable that OJ287 will dip below V=17, which is a very rare event indeed. In fact, the recent data is the faintest level that OJ287 has reached since a very brief minimum in March 1999.

If we look at data since the blazar re-appeared from solar conjunction in September 2024 (Figure 4), with the exception of the flares, the fade in the baseline magnitude over the last few months has been relentless.

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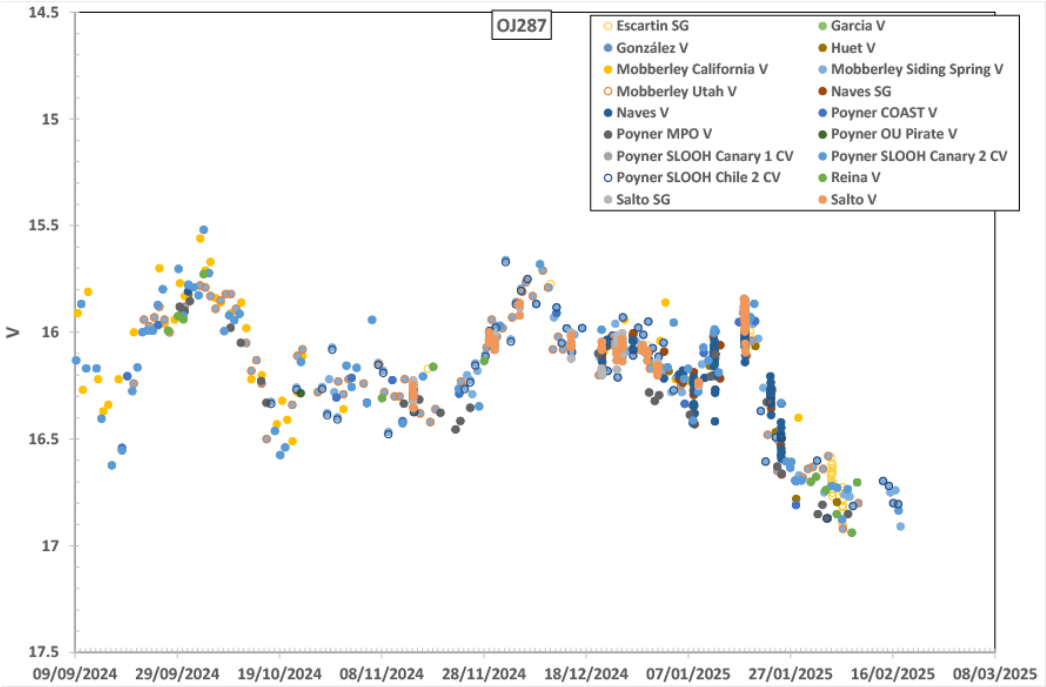

Figure 4. : Data in V since OJ287 emerged from solar conjunction in September 2024, identified by observer. The decline over the last 3 months has been relentless.

However, we would expect that this trend will start to bottom-out. The reason is that the (normally unseen) underlying galaxy is starting to supply an increasing fraction of the total light. The magnitude of the host galaxy of OJ287 – assumed to be a giant elliptical – is estimated to be magnitude V=18.0 [2]. This means that, at V=17.4, the steady brightness of the galaxy contributes 50% of the total light. So, even if the blazar component of the light fades at a steady rate, we would expect this fade to make an increasing small contribution to the total light from the system. The interesting question is just how faint OJ287 will get and how long this unusual minimum will last.

Is OJ287 switching off? The answer is most certainly ‘no’. What is almost certainly happening, though, is that the relativistic jet of OJ287 has misaligned very slightly with our line of sight and, as a result, we have moved some way out of the lighthouse beam, causing the blazar to dim. At some point the jet will snap back and OJ287 will brighten back to its normal level. Until then, we have an amazing opportunity to do something that is impossible when the blazar is brighter.

At these faint magnitudes, the errors on photometry are, inevitably larger, but multicolour photometry is fundamental to measure the host galaxy contribution to the system. As the galaxy is red, it makes the smallest contribution to the total flux in B and the largest in I. So, at faint magnitudes, we start to see important colour changes in OJ287 as the contribution of the host galaxy to the total light of the system gets larger [3]. However, the contribution from the galaxy is quite different in different bands. We should see the B-magnitude showing the largest fade because even at V=17, the contribution of the galaxy to the total brightness in B is only a few percent. In contrast, the constant contribution of the host galaxy in I will be starting to dominate the light of the blazar itself, thus I should fade increasingly slowly at fainter magnitudes in V.

So, this current, deep minimum of OJ287 affords the amateur astronomer to do something with a backyard (or robotic) that the Hubble Space Telescope has so far been unable to do: that is, to detect and study the underlying host galaxy of OJ287.

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Eclipsing Binary News

Des Loughney

desloughney@blueyonder.co.uk

U Cephei

U Cephei is described in our Handbook as a beginner's eclipsing binary. This is because it is easy to find, is observable from the UK all year round, has eclipses often (every 2.493 days) and has a well-defined primary minimum. The drop in magnitude is from about 6.75 magnitude to about 9.24.

The system was our Variable Star of The Year in 2006. The information on the system can be seen on our section's website under the VSOTY menu.

The system was discovered to be an eclipsing binary in 1880. I have been unable to discover the original paper that reported the discovery although there is a reference to a Dr Schmidt in "A.N. 2382". The MNRAS database is now completely searchable but there is no reference to U Cephei in the notes of 1880.

However, I have been able to find in the notes for 1882 reports on observations by George Knott following the discovery (1). The paper refers to observations made between October 1880 and April 1882. There is no reference to a chart or comparisons. The determination of the magnitude of primary minimum at around 9.4 is quite close to the modern figure of 9.24. From his observations Mr. Knott was able to form an opinion that "the period is subject to irregularities - a result quite in accordance with those obtained by other observers." Mr. Knott found that there were alternate sets of primary minimum with the magnitude depth for one set being about 9.2 and the other 9.45. It is hard to credit that visual observers at that time could be confident that the difference was real. Modern measurements do not detect such sets of primary minimum.

There have been many papers written about U Cephei since 1882. One was published in 1979 (2). The introduction to the paper says that the system "has long been known for its irregular behaviour" and that "U Cep ranks as one of the most interesting objects in the sky and bears frequent monitoring." It is prone to outbursts, one of which took place in 1974.

Our VSOTY note states that the primary eclipse minimum lasts two hours and is therefore an example of a total eclipse. The paper (2) states that during the 1974 outburst the primary eclipse was partial. That is a difference that can easily be picked up by amateur astronomers.

U Cephei 1974 to 1976

The paper lists measurements during the period October 1974 to May 1976. They are illustrated in the diagram below. It seems that the measurements were made after the 1974 outburst took place as they suggest that the eclipse is back to being a two-hour total eclipse.

I have not found any references to further 'outbursts' of U Cep since 1974,

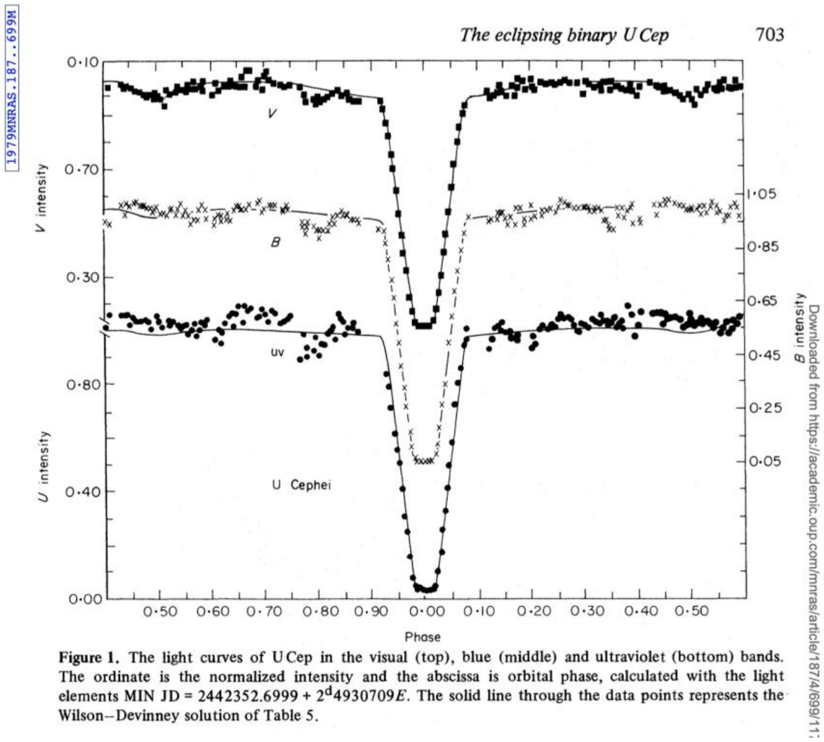


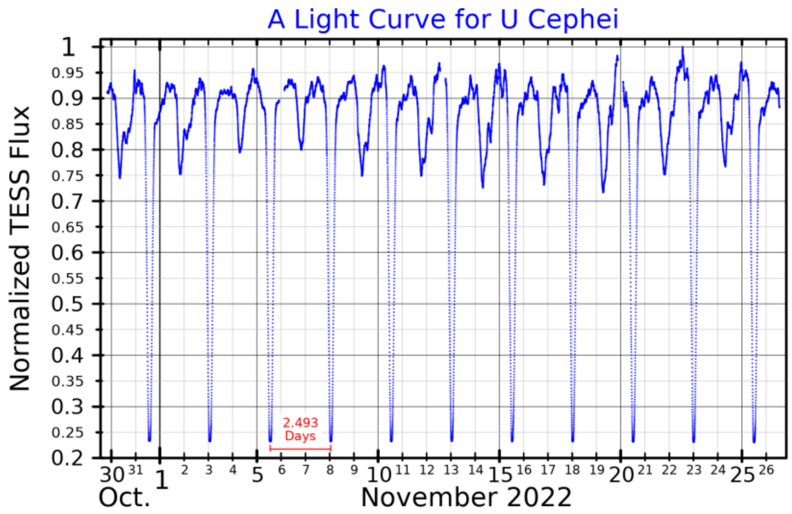
Figure 1. The light curves of U Cep in the visual (top), blue (middle) and ultraviolet (bottom) bands. The ordinate is the normalized intensity and the abscissa is orbital phase, calculated with the light elements MIN JD = 2442352.6999 + $2^d4930709E$. The solid line through the data points represents the Wilson–Devinney solution of Table 5.

U Cephei 2022

U Cephei has been a target of TESS. A lot of information about the system is available by searching the MAST database (3). Below is a set of light curves compiled from data obtained in October to November 2022 which is presented in the Wikipedia entry on U Cephei.

The light curve shows that there is a uniform depth of the primary minimum and suggests that the period is the established period. The secondary minimum eclipse shows some variation. Sometimes it is a depth of 0.15 magnitude, and at other times up to 0.25 magnitude. It would be interesting to find how the variations in the secondary eclipse and the out of eclipse light curve are related to mass transfer and a possible hot spot.

It is possible that this level of variation in the depth of the secondary eclipse could be detected by DSLR photometry especially from dark sky sites with good seeing.



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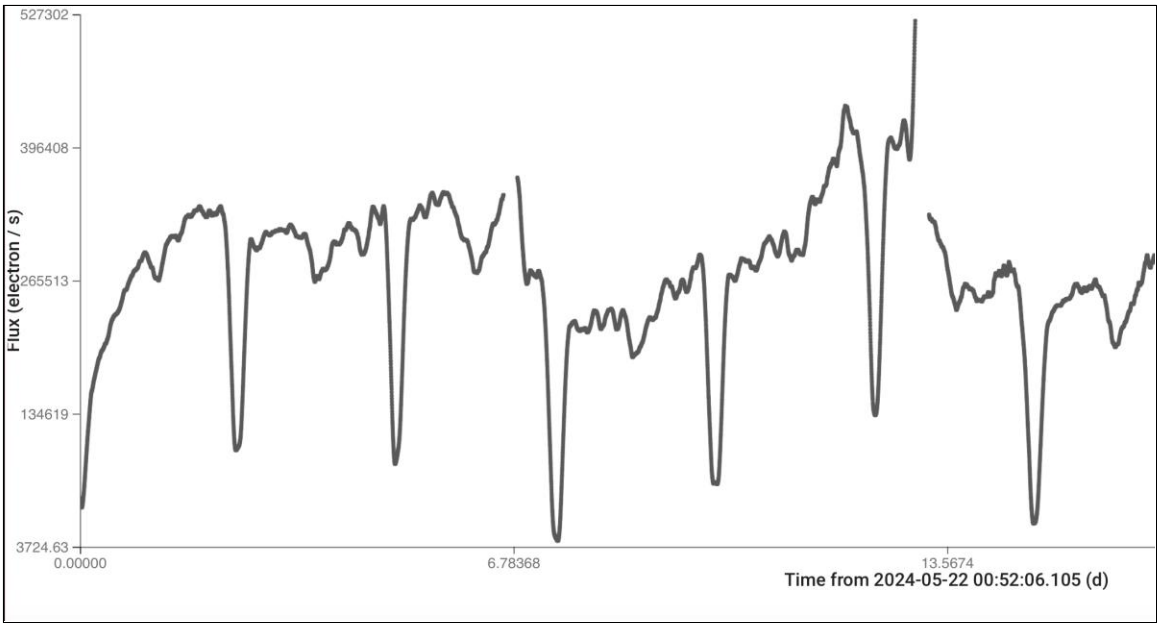
U Cephei 2024

In the diagram below is a MAST (Mikulski Archive for Space Telescopes) presentation of TESS data for a period of time after the 22nd of May 2024. It was found by searching MASTN/ U Cephei/ Tess/Line 20.

Unlike the 2022 data the light curve is very irregular and may illustrate what is an 'outburst' of U Cephei. The primary varies in depth, the secondary varies and in one case seems to vanish. The out of eclipse magnitude varies. It seems that this type of outburst could be picked up by amateur astronomers so the system is well worth studying - not just as a beginner's system.



NASA's Eclipsing Binary Patrol

In order to promote interest in Eclipsing Binaries and citizen science NASA has set up the 'Eclipsing Binary Patrol.'

<https://science.nasa.gov/citizen-science/eclipsing-binary-patrol/>

GTS-EB-7, an eccentric, long period, low mass eclipsing binary

In a recent MNRAS paper (4) is presented analysis of data from TESS and the 'Next Generation Transit Survey (NGTS) which is a facility made up of 12 independent robotic telescopes with 20 cm apertures located in Paranal, Chile. Despite the NGTS facility being Earth based it is thought its data is comparable or better than the TESS data.

The paper studies a system that involves a red dwarf as the secondary star. The system has an exceptionally long period of 193 days. Study of such a system can shed light on the evolution of low mass red dwarfs. In this system the red dwarf has a mass of about 0.096 solar masses which is apparently close to the hydrogen burning limit.

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3. < https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html>
4. NGTS-EB-7, an eccentric, long period, low mass eclipsing binary’ Toby Rodel et al, MNRAS, February 2025, Volume 537, Issue 1.

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The period behaviour of the bright Algol binary RZ Cas

Christopher Lloyd

cl57@ymail.com

The bright, short-period Algol binary RZ Cas has a complex history of period changes but also has intervals where it is more stable. TESS data confirm that the period has been relatively constant over the past five years but has recently increased by 1.85x10^{-5} d. RZ Cas also shows δ Scuti pulsations and the TESS data find f = 64.19431(12) d^{-1} with a semi-amplitude of 2.26(2) mmag.

Introduction

RZ Cassiopeiae (VSX) is a 6th magnitude classical Algol-type eclipsing binary, and has featured regularly in the *Circular*. At maximum it has $V = 6.2$ and primary eclipse is $1^m.54$ deep, so it has attracted attention from both visual, and DSLR observers, but the secondary eclipse is weak at $\simeq$ $0^m.08$ deep. The out-of-eclipse variation is small, at $\sim 0^m.02$ and there is a slight asymmetry (see e.g., Rodríguez et al., 2004). The system has a relatively short period of 1.19525 d and contains an A3V primary and a K0III Roche-lobe filling secondary. RZ Cas is also the prototype of a subclass of oscillating Eclipsing Algol's (oEA), where the primary component is accreting mass and shows δ Scuti-like pulsations due to its location within the instability strip. These variations have a principal period of $0^d.016$ ($f = 64\mathrm{d}^{-1}$) and an amplitude of $\sim 0^m.01$, both of which change over time. Observations of these have been published in the *Circular* by Conner (2022) and more extensive discussions are given by e.g.„ Rodríguez et al. and Mkrtichian et al. (2018).

TESS data

RZ Cas was observed by the Transiting Exoplanet Survey Satellite (TESS) (Ricker et al., 2015) in eight sectors over the past five years. The star was observed by TESS in November and December 2019 (Sectors 18 and 19), May-June 2020 (Sector 25), May-June and November-December 2022 (Sector 52, 58 and 59) and May-June and November-December 2024 (Sector 79 and 86), all at the 2-minute cadence.

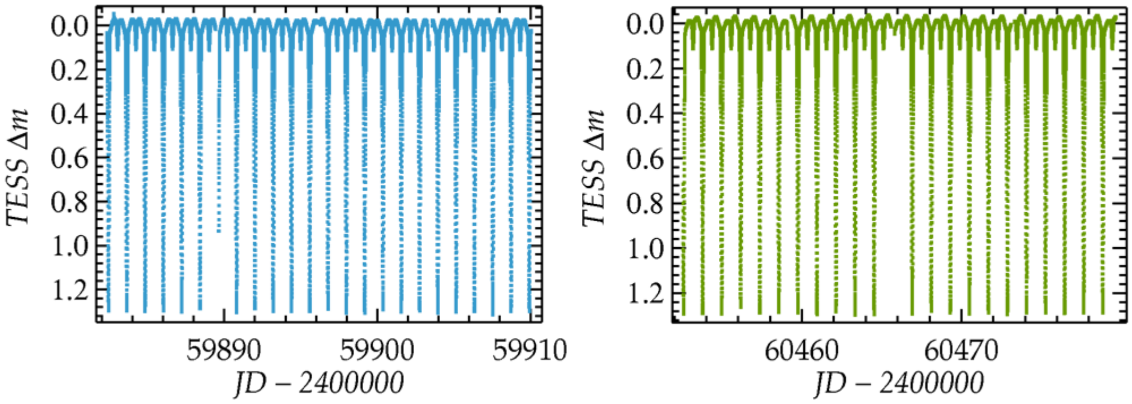

Figure 1: Representative epoch plots of the TESS data from Sector 58 (left) and 79 (right)

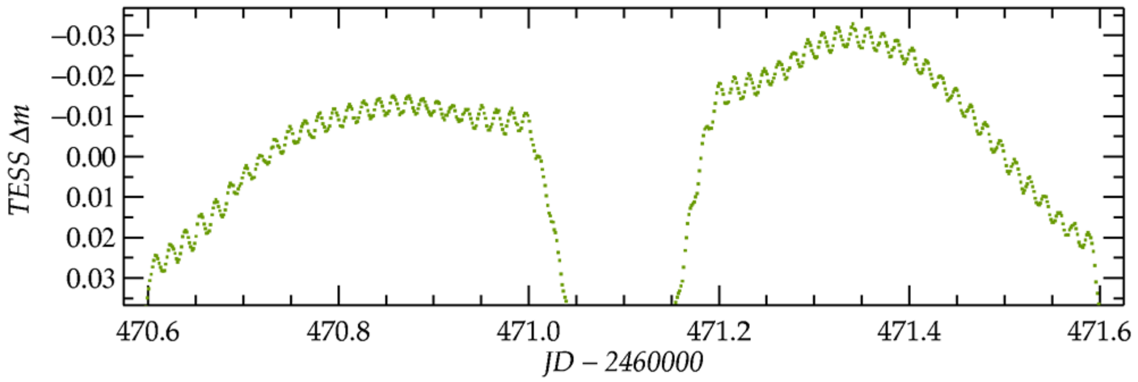

Figure 2: Detail of an individual cycle from Sector 79 showing the light curve between two primary minima. The δ Scuti variations are clearly visible and the plot also shows the difference in level between the two maxima.

The data were downloaded from the MAST archive at the STScI. The simple aperture photometry (SAP) fluxes were used from the high level science products HLSP TESS-SPOC photometry pipeline as these are better background corrected than the other variants, and provided about 18000 data points per sector. Each sector is observed over two 13.7-day orbits, but with up to a day lost each orbit for data download, and also other small gaps can appear at the half-orbit points due to poor background correction. Two representative sectors are shown in Fig. 1 and the high-frequency detail is shown in Fig. 2.

To investigate the high-frequency variation the mean light curve for each sector has been removed, and the sections around the eclipses have been excluded. The Discrete Fourier Transform (DFT) periodogram has been used to identify the frequencies present in the data, and the result from Sector 79 is shown in Fig. 3. There is a single dominant feature, which from a least-squares Fourier fit has f = 64.19431(12) d^{-1} or P = 0.01557771(3) d, with a semi-amplitude of 2.26(2) mmag. There are two weak side lobes at ±1.6739 d^{-1} or 0.5971 d, and these are aliases created by the removal of the eclipses and generate features at half the orbital period.

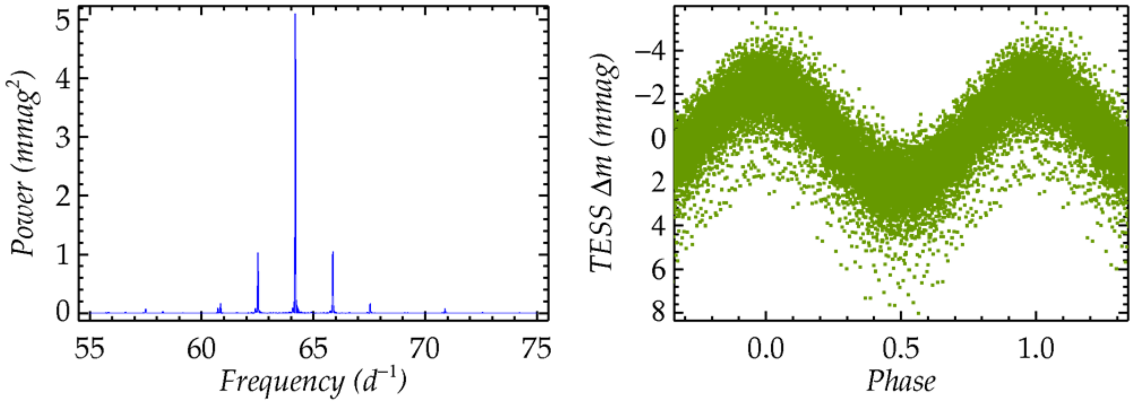

Figure 3: (Left) DFT periodogram of the mean-subtracted TESS data from Sector 79. There is one dominant feature at f =64.2d^{-1} with two weak side lobes that are aliases due to the regularity introduced into the data spacing by removing the eclipses. (Right) The phase diagram of the δ Sct variation folded on the best frequency.

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There are weak residual features in this frequency range, but their semi-amplitudes are < 0.2 mmag. While the primary component may lie within the instability strip that doesn't necessarily mean that it will be variable, and generally the major frequencies of δ Sct stars lie in the 10 – 30 d^{-1} range. The single, dominant, high-frequency pulsation seen here is unusual and may be driven by mass accretion from the cool component (see e.g., Mkrtichian et al., 2018).

The O–C diagram

Times of minima have been taken from the collection of the O–C Gateway, and an additional 30 timings have been taken from Mkrtichian et al. (2018). Where possible times of minima have also been measured from the individual eclipses in the TESS data using the Kwee & van Woerden (1956) (KvW) method. A small number of additional times have been calculated from the original data in the BAA VSS archive. These are listed together with the TESS sector means in Table 1, where those with uncertainties have been measured here using the KvW method. Two others are taken directly from the reports indicated. The mean ephemeris has been determined from the primary photoelectric (pep) and CCD/CMOS timings as

$$HJD_{\mathrm{Min\ I}} = 2450000.0993(7) + 1.1952511(1) \times E \qquad (1)$$

and this has been used to construct the O–C diagram in Fig. 4.

The historical O–C diagram is well covered back to the start of the previous century and it shows a relatively small dispersion of only $\simeq \pm 0^{d}.03$, but the variations are very complex. In detail it shows times of almost continual change in period, in some cases with rapid activity over a few seasons, and also intervals of up to 10 years when the period is arguably constant. Various interpretations of the variations have been offered including light-travel-time effects due to a third body, and apsidal motion (see Hegedus et al., 1992, and references to earlier work), but these fail to explain the rapid period reversals that are a feature of its behaviour. Indeed, this is a defining feature of most Algol binaries.

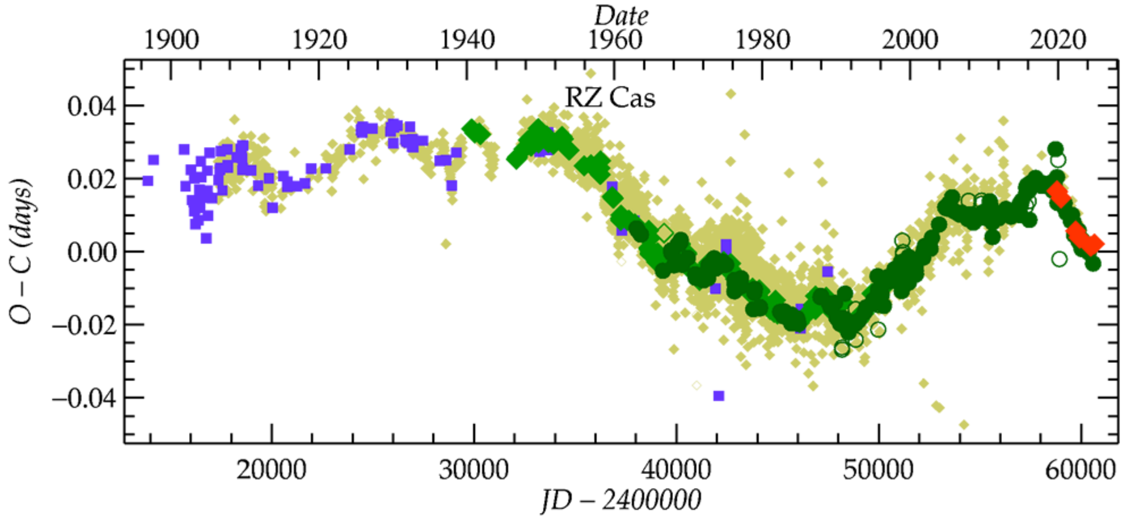

Figure 4: The historical O–C diagram of RZ Cas showing the photographic (blue), visual (brown), photoelectric and CCD/CMOS (green diamonds and circles), and TESS timings (orange). The open symbols show the secondary minima. The diagram is constructed using the mean ephemeris of the primary pep and CCD/CMOS timings in Equation 1.

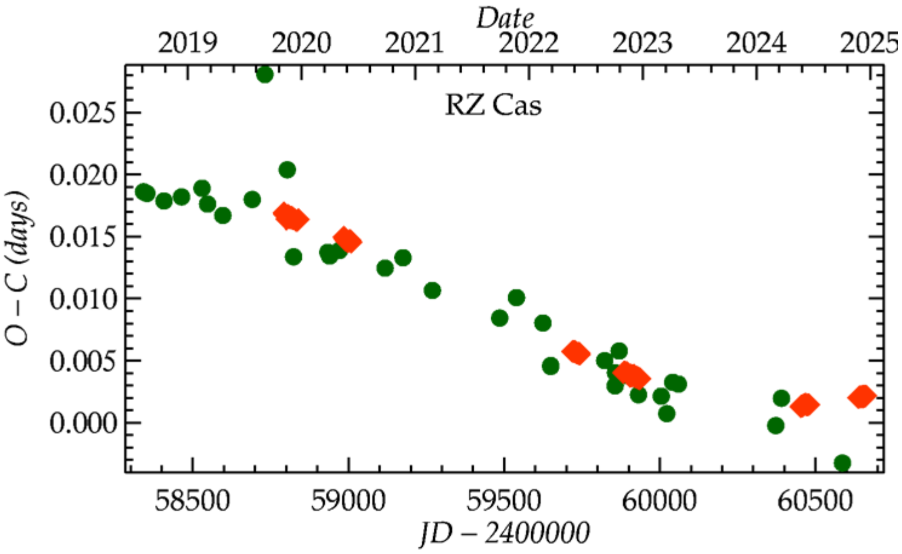

Figure 5: Detail of the O–C diagram of RZ Cas showing the recent CCD/CMOS and TESS primary minima, constructed using Equation 1. The TESS data define a particularly linear run of residuals, but the most recent sectors from 2024 suggest that the period has increased significantly. The symbols are as before.

The generally favoured mechanism is that the period changes are due to episodic variations in the mass-transfer rate related to magnetic cycles in the secondary, but the details are unclear. Mkrtichian et al. (2018) have identified possibly three periods in the O–C data on the 4 – 9-year time scale that influence the rate of period change, and these are interpreted as significant in the magnetic cycle of the cool component. The most recent data are shown in Fig. 5, where the TESS data in particular, highlight one of the linear sections of the O–C residuals. The section from ~2019 – 2023 represents the shortest mean period in the observed O–C diagram of RZ Cas and is comparable only to the section around 1960 – 1970. However, the most recent TESS sectors from 2024 suggest that the mean period has increased from 1.19523706(3) to 1.19525556(10)d, or by +1.85x10^{-5} d, with an instantaneous change of $\Delta P/P$ = +1.55x10^{-5}.

For observers of this system, and Algol binaries in general, it is important to be aware of the impact of period changes on the anticipated times of eclipses. All ephemerides have a shelf life, and some are much shorter than others, so they should be considered along with the O–C diagram they generate. Although the mean ephemeris for RZ Cas in Equation 1 currently has residuals close to zero, that will obviously change and the eclipses will appear progressively later, probably for the next year or two. These differences are not likely to lead to an eclipse being only partially observed, but this may not be the case for other system, and the data archives contain plenty of truncated eclipses, taken at no small effort, that will be of little use. RZ Cas is a bright system and ideally suited to small telescopes, so here is where the burden of making these timings will fall. Given the complexity of the variations, the system would benefit from rather more intensive monitoring to track the subtle changes in period.

Table 1: Times of minima from individual eclipses and TESS sector means

HJD	σ	Band	Observer	Source
2454513.37752	0.00069	TG	D.Loughney	
2465729.37337	0.00105	V	D.Loughney	
2457513.46654	0.00007	TG	J.T.Screech	
2457745.34657	0.00005	TG	J.T.Screech	
2457745.34479	0.00004	CV	D.S.Conner	
2458529.43001	0.00005	CV	D.S.Conner	
2458547.3575	0.	V	D.Loughney	VSSCirc 180, 26
2458804.335494	0.000022	TESS		
2458829.435520	0.000013	TESS		
2458997.964229	0.000017	TESS		
2459485.62042	0.00019	TG	C.Watkins	
2459539.40837	0.00170	V	D.Loughney	VSSCirc 202, 40
2459731.839369	0.000009	TESS		
2459896.782310	0.000013	TESS		
2459923.077569	0.000009	TESS		
2460041.40700	0.00086	V	D.Loughney	VSSCirc 198, 35
2460468.109821	0.000012	TESS		
2460586.435	0.	V	D.Loughney	VSSCirc 202, 40
2460646.202896	0.000009	TESS		

Acknowledgements

The author is pleased to acknowledge the use of the NASA/ADS, the SIMBAD database and the VizieR catalogue access tool. The author gratefully acknowledges use of the AAVSO Variable Star Index (VSX). The author also gratefully acknowledges the Czech Astronomical Society for supporting the O–C Gateway and to the BAV for supporting the Lichtenknecker Database. 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.

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Hegedus, T., Szatmary, K., & Vinko, J., 1992, *Ap&SS*, **187**, 57

Kwee, K. K. & van Woerden, H., 1956, *Bulletin of the Astronomical Institutes of the Netherlands*, **12**, 327

Mkrtichian, D. E., Lehmann, H., Rodrıguez, E., et al., 2018, *MNRAS*, **475**, 4745

Ricker, G. R., Winn, J. N., Vanderspek, R., et al., 2015, *Journal of Astronomical Telescopes, Instruments, and Systems*, **1**, 014003

Rodrıguez, E., Garcıa, J. M., Mkrtichian, D. E., et al., 2004, *MNRAS*, **347**, 1317

KU Cygni and RZ Ophiuchi observation updates

David Conner

david@somerbyconners.plus.com

Observations of eclipsing binaries over a period of several years can show variations in their light curves which themselves can take a number of years to become visible, as is shown in the light curves of KU Cygni and RZ Ophiuchi discussed in this article.

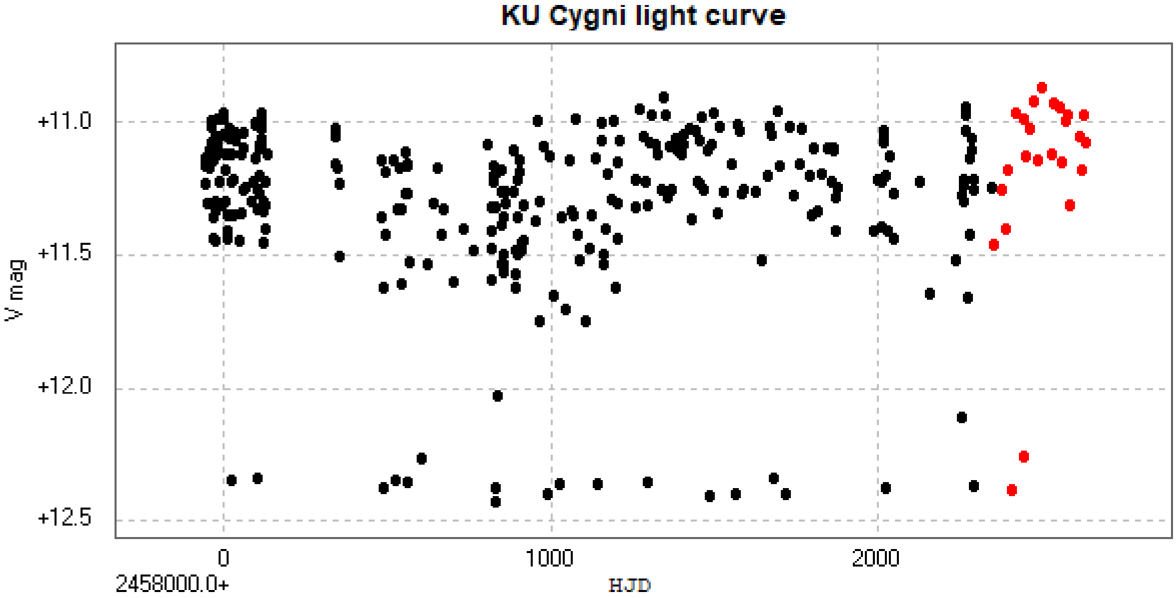
Long term observations of KU Cygni and RZ Ophiuchi have shown that the maxima after the primary and secondary minima of KU Cygni have varied in brightness over a period of approximately 1250 days. On the other hand, only the maxima after the primary minima of RZ Ophiuchi have shown any significant variation.

The catalogue data, in square brackets, was correct as of 2025 February 13. All observations were made with remote telescopes and, except where noted, using a V filter.

KU Cygni

[GCVS type EA/D:/RS, period 38.4393d, spectrum F4p+K5eIII, AAVSO VSX type EA/GS, period 38.4396d, spectrum B7:V+K5IIIe]

This system was previously discussed in BAA Variable Star Section *Circular* 195. Here is an updated light curve and best fit phase diagram constructed from 310 observations between 2017 July 7 and 2024 November 22. The more recent results, obtained between 2024 February 11 and 2024 November 22, are in red.



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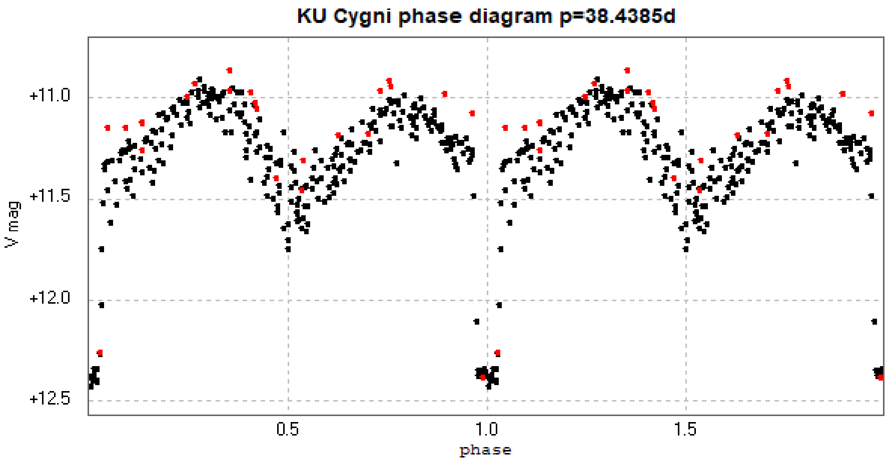
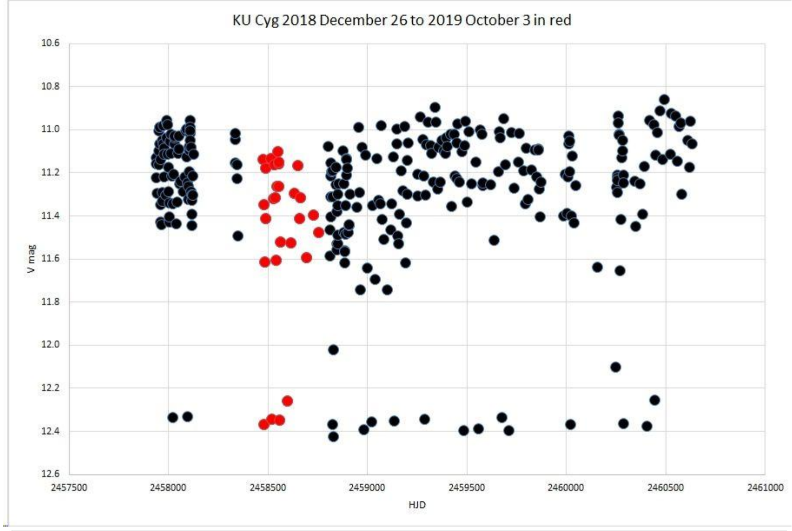
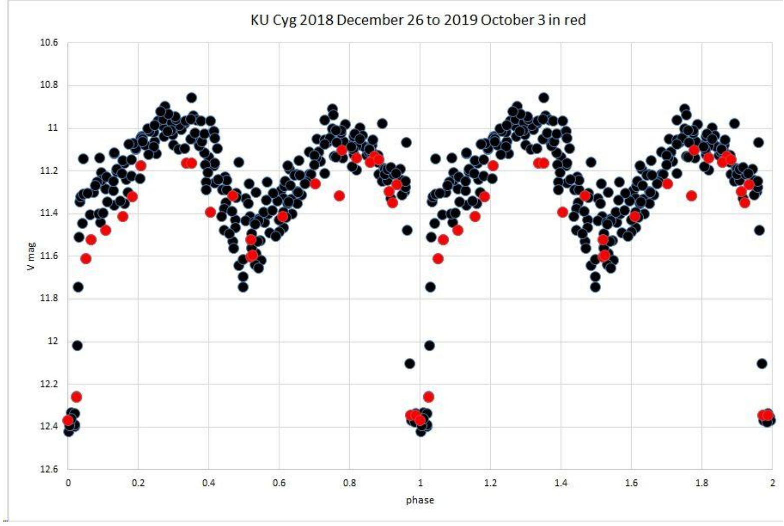


The orbital period of this system is approximately 38.44 days (the best fit to these observations alone is 38.4385d). Superimposed on this is a sinusoidal variation in the maxima with a period of very approximately 1250 days. From the observations since 2024 February it would appear that most of the light curve – with the exception of the more consistent primary minima – is essentially at it brightest since my observations began. This compares to a time of the less bright maxima between 2018 December 26 and 2019 October 3 shown below.





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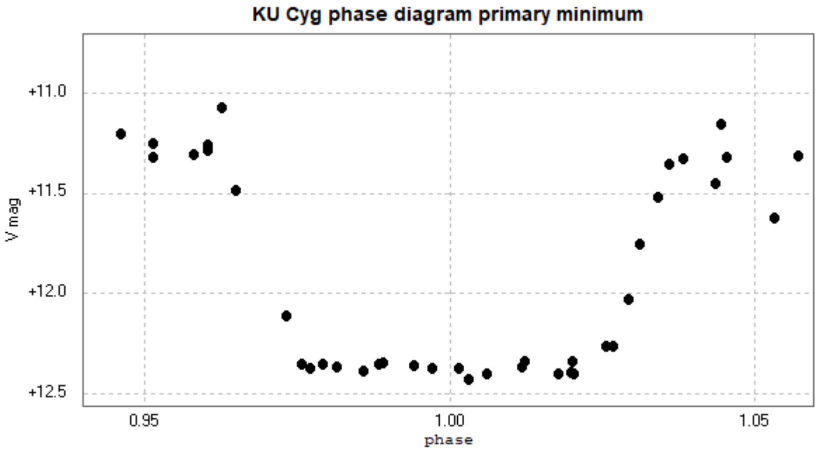
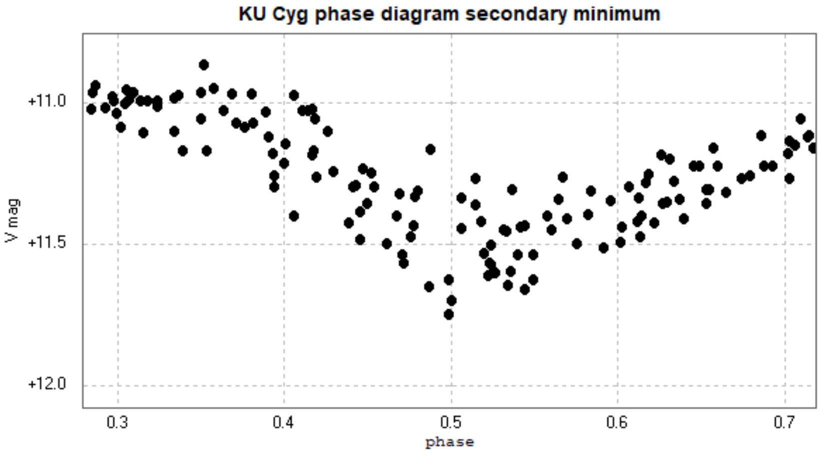
Enlargements of the symmetric primary and asymmetric secondary minima follow, note the different scales of the axes. The observation that the primary minimum does not exhibit such scatter suggests that the cause of the scatter is due to variations in or around the smaller, higher temperature component.


KU Cyg phase diagram primary minimum


KU Cyg phase diagram secondary minimum

They might be due to luminosity changes in an eccentric accretion disc (Otero 2011). Papers about this system include Popper (1964), Olson, Etzel and Dewey (1995) and Smak and Plavec (1996). Precession of an eccentric disc around one of the components has been suggested by Smak and Plavec. Alternatively, the GCVS lists it as an RS Canum Venaticorum variable, which might be relevant.

There is a short video on YouTube illustrating these changes to the phase diagrams here.

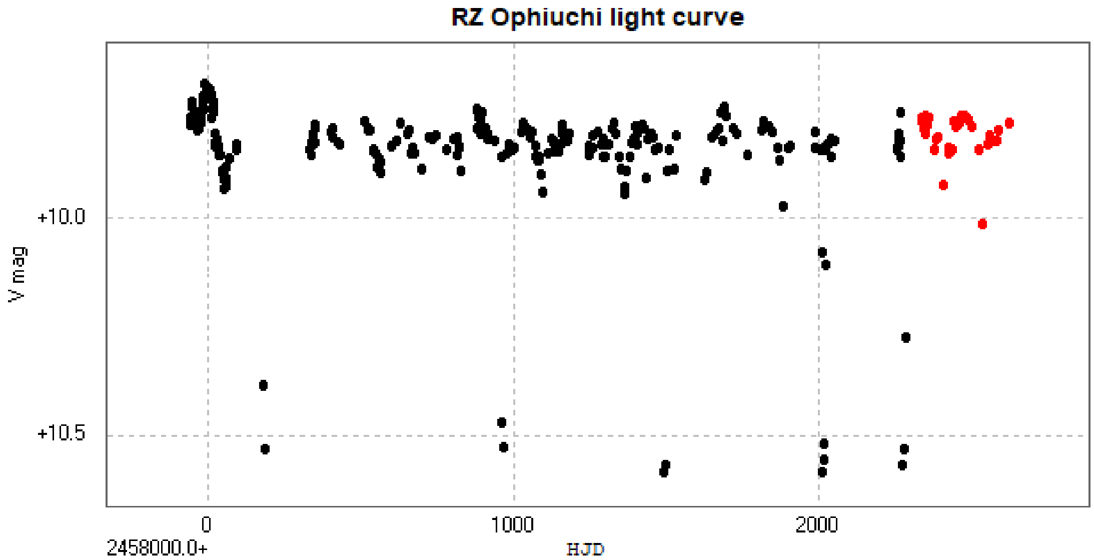
RZ Ophiuchi

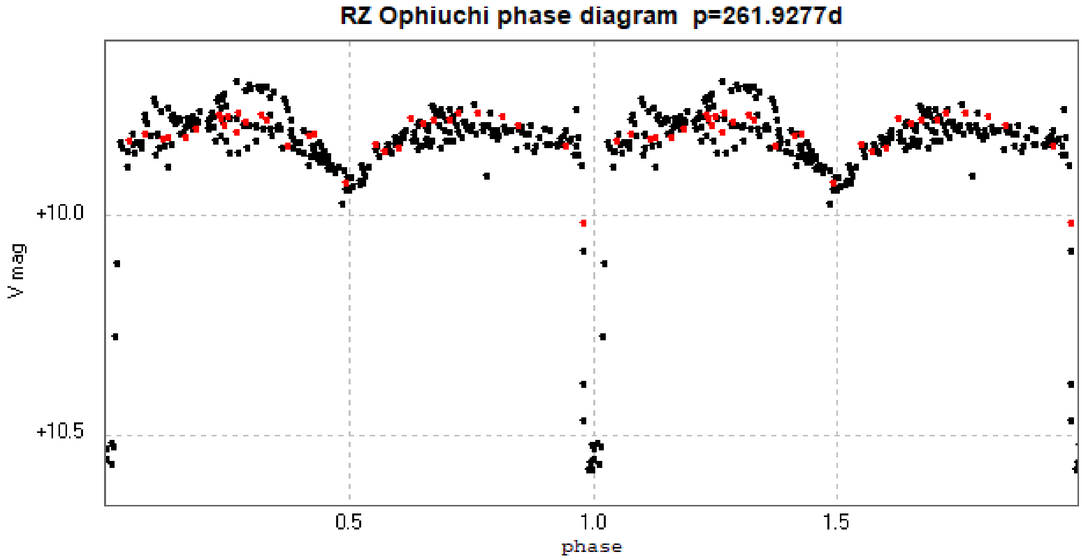
[GCVS type EA/GS, period 261.9277d, spectrum F3eIb+K5II, AAVSO VSX type EA/GS , period 261.9277d, spectrum F3eIb+K5II]

This system was previously discussed in BAA Variable Star Section Circular 183.

Data has been obtained from photometry of 300 images which I requested of this star with the Open University COAST telescope between 2017 July 5 and 2024 November 10, using a V filter. The observations have not been transformed.

Of these, the latest 32 observations between 2024 January 28 and 2024 November 10 are in red in the following light curve and phase diagrams.





An enlargement of the maximum between phase 0 and phase 0.5 appears below. The three separate light curves between phase 0.2 and phase 0.4 approximately is of interest. Enlargements of the two minima are also shown. The light curve includes possible effects of a disc around the hot star. An article discussing this system, *Olson (1987)*, can be found here.

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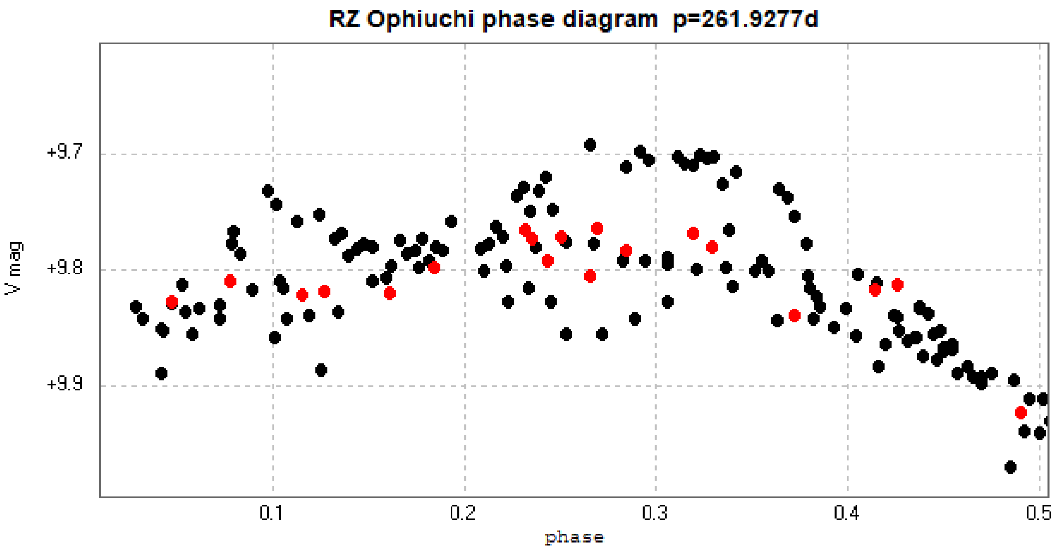

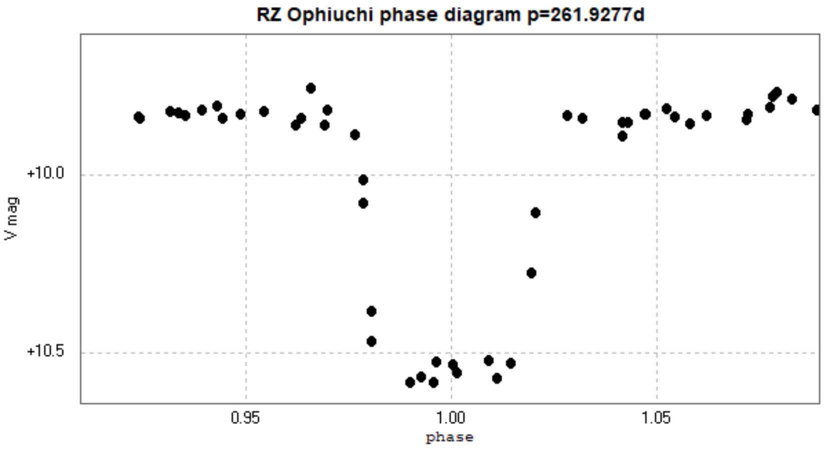

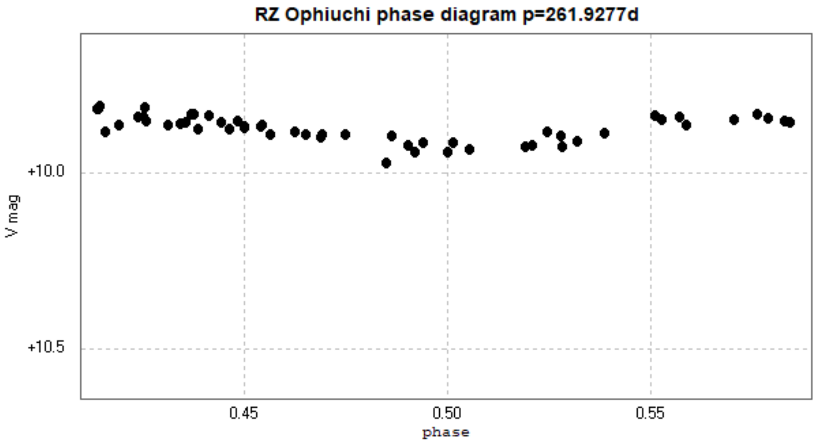

A fuller description of these systematic changes over time can be found on my website

As ever, more observations will be requested to check on any future variations.

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Variations of the low-amplitude eclipsing binary HD 258049 and further evidence of spots in early-type systems

Christopher Lloyd and John Greaves

cl57@ymail.com

The 10th magnitude star HD 258049 is confirmed as a low-amplitude eclipsing or ellipsoidal binary, with eclipse depths of 0.045 and 0.02 mag, and a period of 3.9412 d. The system probably contains two similar stars, perhaps B9.5 V and A2 V, and the light curve shows a variable O'Connell effect and evolves over time, with changes in both the eclipse depths and timings, indicative of spots.

Introduction

HD 258049 (VSX) is a previously unremarkable 10th magnitude star that has been used as a comparison for observations of the exoplanet transits of Wasp12b. During a 5-hour run on 2025 January 27 the star showed an approximately sinusoidal variation on a time scale of $\simeq 0.06$ d, with a full amplitude of $0^{m}.07$ (Langill & Oberhamer, 2025). It has apparently not been noticed as variable in any other photometry of Wasp12b. Although HD 258049 is not a confirmed variable, it has been lurking in the data archives. It is listed as an ellipsoidal binary candidate by Green et al. (2023), with a period of 3.9371 d, and a similar period was also identified by Oelkers et al. (2018). The star was found to be a spectroscopic binary from a small number of spectra by Fossati et al. (2013), and more recently listed as an SB2 by Zheng et al. (2023) based on LAMOST data, although in both cases they provide no other details. *Gaia* DR3 (Verberne et al., 2024) gives the radial velocity as -168 ± 184 kms^{-1}, which presumably means that an orbit will be forthcoming eventually. The spectral type is widely reported as A1V, but measurements of the temperature vary quite widely from $T_{\mathrm{eff}} \simeq 10000$K from *Gaia* DR3 to ~ 7000K from LAMOST DR8 (see e.g., Wang et al., 2023, and other sources).

Gaia DR3 gives the mean magnitude as $G = 10.472(1)$ with $(G_{BP} - G_{RP}) = 0.364$, and a distance $d =$ 750pc. The additional Apsis processing chain gives the extinction $A_{\mathrm{G}} = 0.742$ and the absolute magnitude as $M_{\mathrm{G}} = 0.345$. According to the Rochester calibration (see Pecaut & Mamajek, 2013, for details) A1V stars have $M_{\mathrm{G}} = 1.32$ so even if the binary contained two similar stars, the combined luminosity could not reach the *Gaia* value of $M_{\mathrm{G}} = 0.345$. Assuming that there is no third light, and that the components are unevolved, then the primary component could be earlier, probably a late B-type star, with the secondary slightly later and cooler, but still luminous enough to be visible in the spectra of the system. If the magnitude difference between the components is $0^{m}.5$, then stars with $M_{\mathrm{G}} = 0.9$ and 1.4 could produce the correct combined luminosity, and the corresponding spectral types of B9.5 and A2 would be consistent with what is seen.

TESS data

HD 258049 was observed by the Transiting Exoplanet Survey Satellite (TESS) (Ricker et al., 2015) in six sectors over the past five years. The star was observed by TESS in November-December 2019 (Sectors 20), September-December 2021 (Sectors 43, 44 and 45), and October-December 2023 (Sector 71 and 72). Sector 20 was taken at the 30-minute cadence, Sectors 43, 44 and 45 at the 10-minute cadence, and Sectors 71 and 72 at the 200-second cadence.

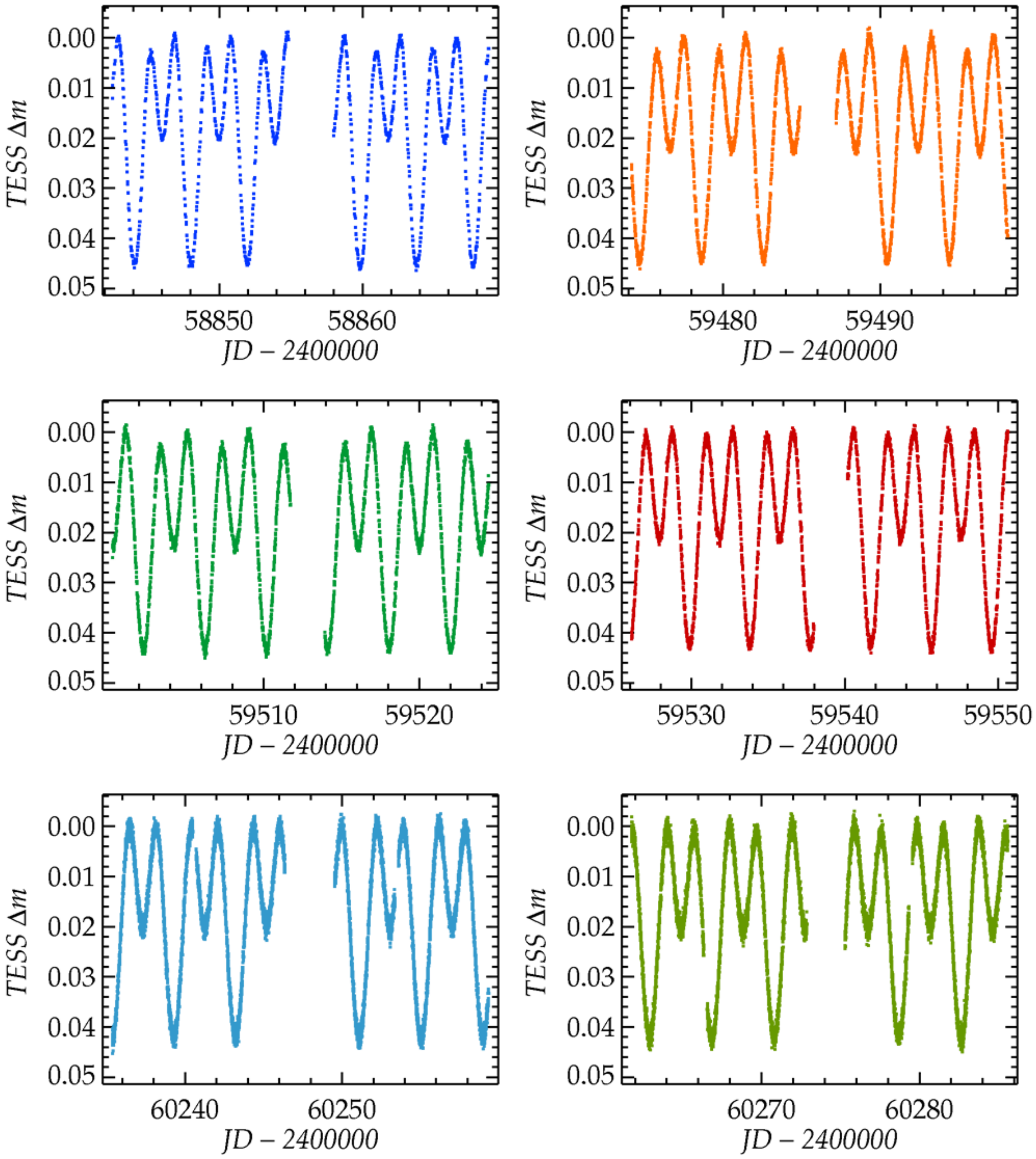

Figure 1: Epoch plots of the TESS data from Sectors 20, 43, 44, 45, 71 and 72. The magnitudes have been corrected for inter-orbit trends and offsets and each sector is rectified to the maximum brightness of the Fourier fits to the phase diagrams as in Fig. 2.

The data were downloaded from the MAST archive at the STScI, and the PDCSAP aperture photometry fluxes were used from the high level science products HLSP TESS-SPOC photometry pipeline. The number of data points ranged from ≃ 1000 to ≃ 8700 per sector, depending on the sampling rate. Each sector is observed over two 13.7-day orbits, but with up to a day lost each orbit for data download, and also other small gaps can appear at the half-orbit points due to the high background. Due to the limitations of the background removal there are frequently systematic trends or offsets in the fluxes between the two orbits in each sector, and between the halves of each orbit. Each sector has been fitted with an initial 4-harmonic Fourier series to model the light curve, and the residuals have been fitted with low-order polynomials over the sector to remove the mean trends and offsets between the orbits.

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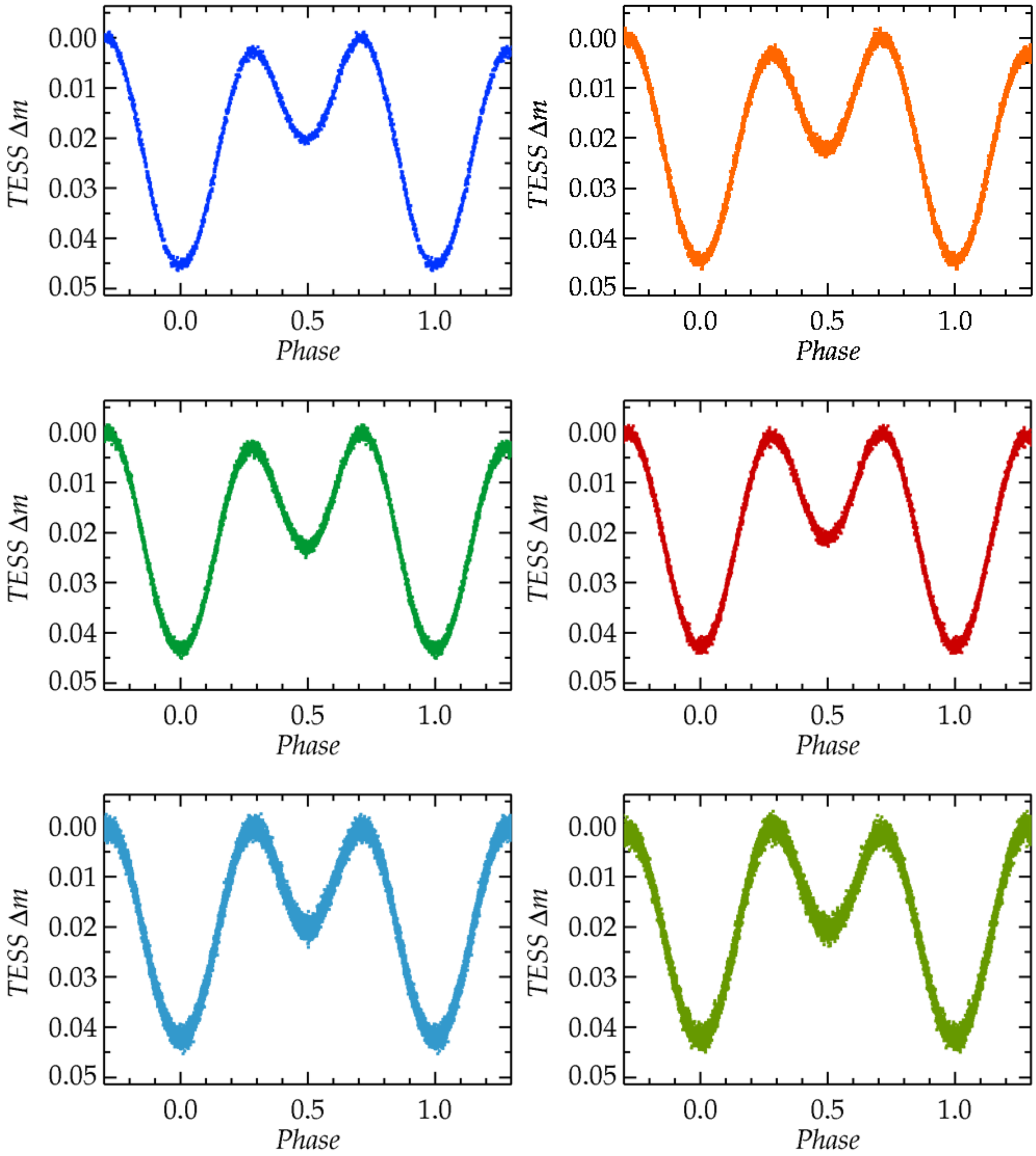

Figure 2: Corresponding phase diagrams of the data in Fig. 1.

These corrections are usually small, up to a few mmag, and can be of very different forms, but it is very unlikely that any significant part of the variation of the star has been corrected away. The detrended data have then been refitted with the 4-harmonic Fourier series and rectified by subtracting the maximum brightness of each fit.

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Table 1: Times of minima from individual TESS eclipses

HJD	σ	Min.	Cycle	O–C	HJD	σ	Min.	Cycle	O–C
2458844.0925	0.0027	1	0.0	+0.0107	2459523.9443	0.0033	2	172.5	−0.0025
2458846.0183	0.0027	2	0.5	−0.0342	2459527.8878	0.0034	2	173.5	−0.0003
2458848.0340	0.0027	1	1.0	+0.0109	2459529.8660	0.0018	1	174.0	+0.0073
2458849.9734	0.0031	2	1.5	−0.0203	2459531.8262	0.0019	2	174.5	−0.0031
2458851.9626	0.0012	1	2.0	−0.0017	2459533.8048	0.0015	1	175.0	+0.0048
2458853.8983	0.0020	2	2.5	−0.0367	2459535.7622	0.0016	2	175.5	−0.0084
2458859.8461	0.0020	1	4.0	−0.0008	2459541.6920	0.0018	1	177.0	+0.0096
2458861.7876	0.0032	2	4.5	−0.0299	2459543.6521	0.0021	2	177.5	−0.0009
2458863.7835	0.0016	1	5.0	−0.0045	2459545.6335	0.0019	1	178.0	+0.0098
2458865.7401	0.0030	2	5.5	−0.0186	2459547.5927	0.0029	2	178.5	−0.0016
2458867.7338	0.0019	1	6.0	+0.0044	2459549.5658	0.0018	1	179.0	+0.0009
2459474.6935	0.0019	1	160.0	+0.0123	2460237.3061	0.0011	2	353.5	−0.0063
2459476.6225	0.0026	2	160.5	−0.0294	2460239.2850	0.0010	1	354.0	+0.0020
2459478.6389	0.0020	1	161.0	+0.0164	2460241.2610	0.0013	2	354.5	+0.0073
2459480.5666	0.0024	2	161.5	−0.0266	2460243.2188	0.0015	1	355.0	−0.0055
2459482.5823	0.0015	1	162.0	+0.0186	2460245.1915	0.0016	2	355.5	−0.0034
2459484.5033	0.0047	2	162.5	−0.0311	2460251.0952	0.0011	1	357.0	−0.0116
2459488.4441	0.0036	2	163.5	−0.0315	2460253.0644	0.0029	2	357.5	−0.0130
2459490.4644	0.0023	1	164.0	+0.0181	2460255.0408	0.0008	1	358.0	−0.0072
2459492.3965	0.0027	2	164.5	−0.0204	2460257.0192	0.0010	2	358.5	+0.0006
2459494.4044	0.0013	1	165.0	+0.0169	2460258.9786	0.0019	1	359.0	−0.0107
2459496.3427	0.0027	2	165.5	−0.0154	2460262.9193	0.0013	1	360.0	−0.0113
2459502.2832	0.0020	1	167.0	+0.0133	2460264.9110	0.0014	2	360.5	+0.0098
2459504.2262	0.0040	2	167.5	−0.0144	2460266.8611	0.0011	1	361.0	−0.0107
2459506.2265	0.0018	1	168.0	+0.0152	2460268.8425	0.0016	2	361.5	+0.0001
2459508.1622	0.0046	2	168.5	−0.0196	2460270.8047	0.0018	1	362.0	−0.0083
2459510.1724	0.0020	1	169.0	+0.0199	2460276.7335	0.0014	2	363.5	+0.0086
2459516.0509	0.0033	2	170.5	−0.0134	2460278.6897	0.0013	1	364.0	−0.0058
2459518.0520	0.0016	1	171.0	+0.0171	2460282.6340	0.0017	1	365.0	−0.0027
2459519.9871	0.0030	2	171.5	−0.0185	2460284.6321	0.0015	2	365.5	+0.0247
2459521.9940	0.0017	1	172.0	+0.0178					

The epoch plots of the corrected data are shown in Fig. 1, where the inter-orbit (and some half-orbit) gaps in the TESS data and the change in cadence can be seen. The variation of the eclipsing binary is also clearly visible over its 4-day orbit, but the amplitude is low, with depths of $0^m.045$ and $0^m.02$ for the primary and secondary eclipses respectively. The difference in eclipse depths is broadly consistent with the notion that the components have similar T_{eff}s and radii. The corresponding phase diagrams are shown in Fig. 2 and over the six sectors some evolution of the light curve is visible. The most obvious feature is the change in the O’Connell effect (O’Connell. 1951; Wilsey & Beaky, 2009) where the first maximum is clearly fainter in the first three sectors, then the maxima equalize in Sector 45, with the first maximum becoming marginally the brighter in the last sector. These changes are mirrored by small variations in the depth of both eclipses. It is not entirely clear if the system is actually eclipsing – and the low amplitude may argue against it, or if the variations are completely due to the ellipsoidal distortion of the stars. There is obviously a significant ellipsoidal component, and the displacement of the maxima from the quadrature points indicates a low inclination, but a definitive

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answer needs a more detailed light curve analysis. However, this has no impact on the presence or effect of spots.

Variations in the shape of light curves are familiar in cooler systems like W Ursae Majoris stars, where the incidence of chromospheric activity is high, and spots are common. Although rarer in early-type systems, chromospheric activity, spots and flares do occur. Rotational modulation of the light, which is thought to be due to spots, was found in about 40% of A-type stars in the Kepler field by Balona (2013) and activity in the form of flares was found in about 1.5% of the sample (see also Balona, 2021). Even Vega has spots (Böhm et al., 2015). So, it seems likely that these variations are due to changes in the surface activity on one or both of the components, and this can obviously occur quickly as the major change in Fig. 2 occurs between adjacent sectors, 44 and 45.

The O–C diagram

Times of minima have been measured from the individual eclipses in the TESS data using the Kwee & van Woerden (1956) (KvW) method. A small number of partially observed eclipses that did give viable solutions were discarded, and equally some eclipses that contained gaps were retained if their uncertainties were not excessive. The weighted mean ephemeris based on both primary and secondary eclipses is

$$HJD_{\mathrm{Min\ I}} = 2458844.0819(5) + 3.9412463(17) \times E \qquad (1)$$

and this has been used to construct the O–C diagram in Fig. 3, while the results are listed in

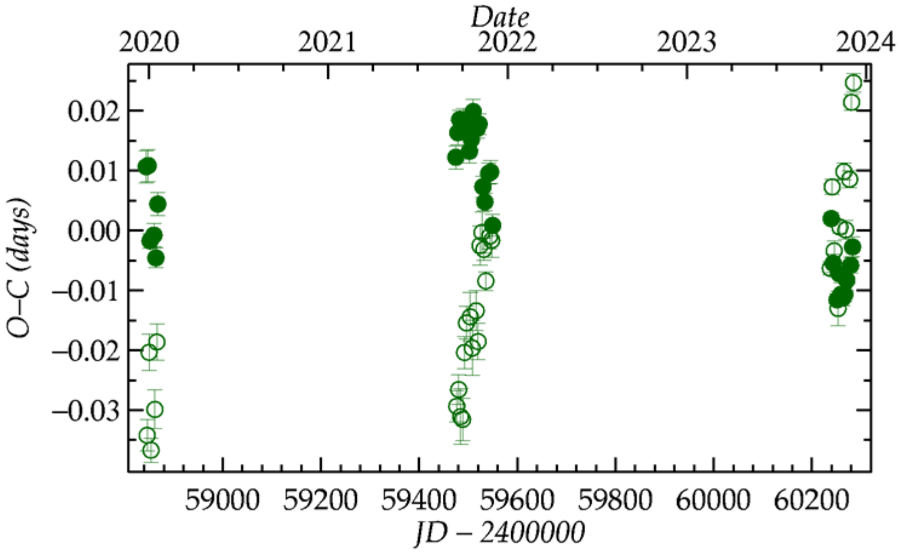

Figure 3: The O–C diagram of HD 258049 TESS timings with the secondary minima shown by open symbols. The diagram is constructed using the weighted mean ephemeris of the all the timings in Equation 1.

Table 1. The most obvious feature is the variation in the timing of the secondary minimum, which occurs early in the first sectors, rapidly increases during Sectors 43, 44 and 45, and occurs late in the last sectors. Again, these variations mirror the changes in the phase diagram in the depth of the eclipses and the relative heights of the maxima and point to features moving on the surface of the star. In the central sectors the timing of the primary minimum appears to move in opposition to the secondary, but generally it appears more stable. As the inclination is low and most of the surface of both stars remains visible, it is not possible to suggest the location of any spots without a more detailed light curve analysis.

Summary

Attention was drawn to HD 258049 by the recent report of significant short time-scale variations by Langill & Oberhamer (2025), but there is nothing in the history of the star, nor in the analysis of the TESS data that hints at any variation on this scale. Instead, the TESS data confirm that the star is a low amplitude eclipsing or ellipsoidal variable, probably containing two similar stars near B9.5V and A2V. The light curve is variable and shows many of the signatures of spots. More may become clear when an orbital solution becomes available.

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