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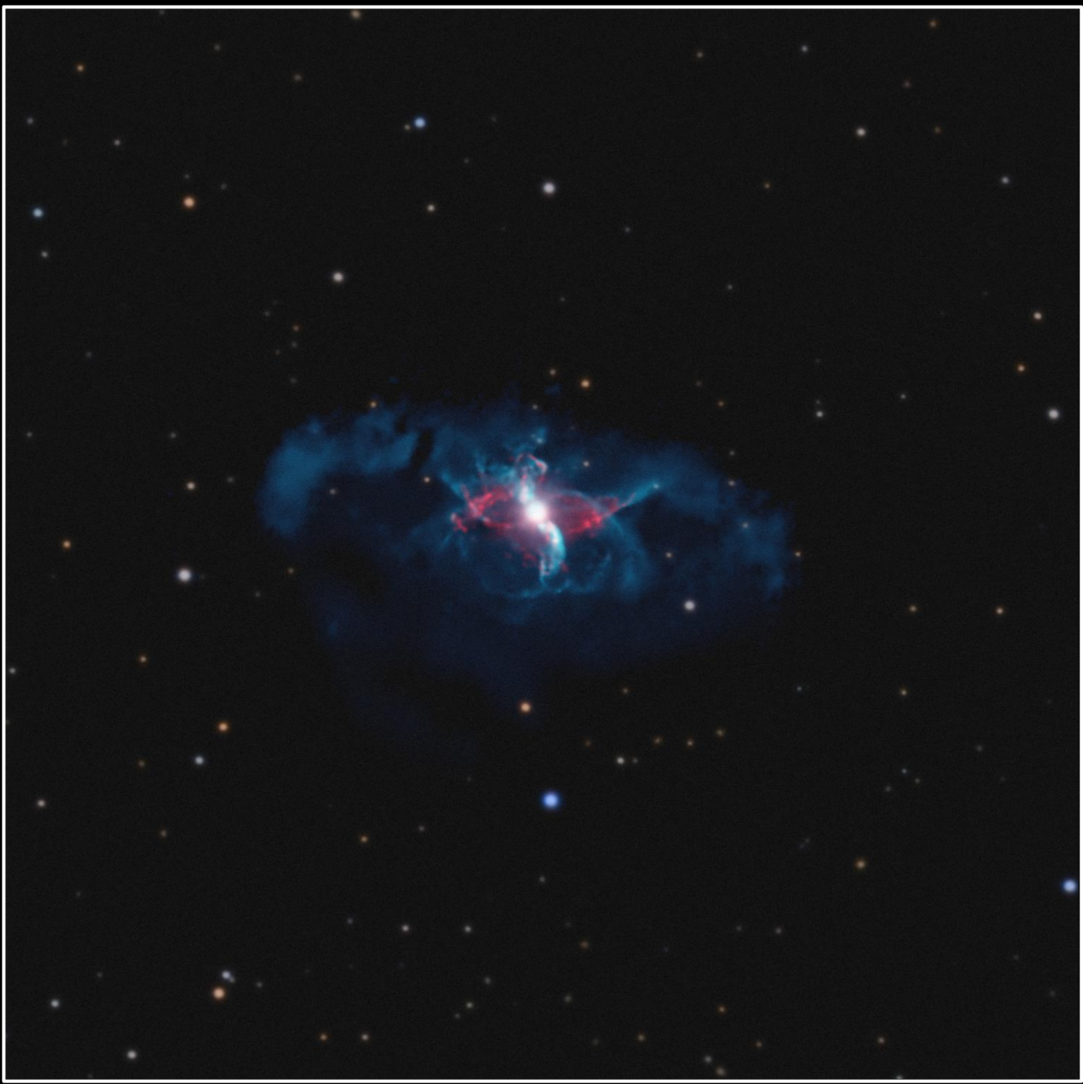

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Contents

Cover Picture

R Aqr - Peter Goodhew

See page 9 for details.

From the Director *Jeremy Shears*

Roger Pickard (1943-2023)

Roger Pickard with his 35cm Meade LX200 SCT at his home observatory on 2023 Aug 25

It is with the deepest sadness that I have to inform you that Roger passed away in the early hours of Boxing Day, 2023 Dec 26, at the age of 80.

Roger was a past President of the BAA (2007 - 2009) and Director of the Variable Star Section from 1999 to 2019, making him the longest serving Director. He was, of course, a great variable star observer and was awarded the Association's Merlin Medal in 2020 for his VS contributions. Roger very much enjoyed attending the recent Section meeting in Northampton and it was wonderful to see him there.

I have known Roger since 1988 when we met at Maidstone Astronomical Society in Kent and he has constantly encouraged my efforts in VS astronomy. He was a true gentleman and a wonderful encourager of people. I last visited him, his wife Marian and their new dog Snowy at their

Back to contents

Herefordshire home only 2 weeks before his death. We spent a very pleasant morning catching up on VS matters.

Roger will be missed by all who knew him and who cherished his friendship. Sincere condolences to Marian and his children, Christopher, Stella, and James. It is surely a great comfort to them that his work and legacy will live on.

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

VSS archives

During 2023, Roger Pickard indicated that he was keen that VSS archival observations that were stored at his home should be moved to a central BAA facility. I visited him in August to assess the type and quantity of material. Most is handwritten visual estimate forms that he had collected over the years. Whilst all have been entered into the VSS database it seemed a pity to dispose of the originals. Having consulted with BAA Archivist, Dr Richard McKim, the decision was taken to deposit them in the BAA secure store at Bedford.

A three-step transfer processes was adopted to ensure safe and secure transport of the material. I visited Roger's house in the beautiful Herefordshire countryside at Shobdon in December and we transferred the contents of 4 filing cabinets of files into file boxes. The rate limiting step in this process soon became apparent: we kept coming across observations by past observers, or of particular stars, which would lead us down various pleasant byways in discussing them. Eventually the boxes were loaded into my car and I took them home to Cheshire.

Once at home, I packed and secured the file boxes ready for collection by an overnight courier to Richard McKim's home. Richard then kindly took them to the BAA Bedford store, where they now safely reside. Upon hearing the successful conclusion, Roger said it was a great weight off his mind.

VSS archival observations loaded in the Director's car at Shobdon ready for transfer to the BAA store

400K visual milestone for Rod Stubbings

As reported on BAAVSS-Alert on 2024 February 10, Rod Stubbings has achieved a remarkable visual observing milestone. He writes:

Tonight, I have made my 400,000th variable star observation! So, this has taken 30 years and 9 months. I had to observe 148 stars to reach this total. Started at 9:00pm and got there by 11:11pm, then came inside to have a break and cup of tea. It was on VW Hyi probably the most observed star in the southern skies, and it's currently having a super-outburst. I have over 4000 obs of this star and a nice light curve. Clear all night, so I'm going back out again to see what I can find. The year has started off well with 2700 obs for January and up until tonight over 1800 observations for February, and a run of clear nights ahead.

Hearty congratulations to Rod on this amazing achievement which John Toone notes has only previously achieved by Albert Jones and Hiroaki Narumi!

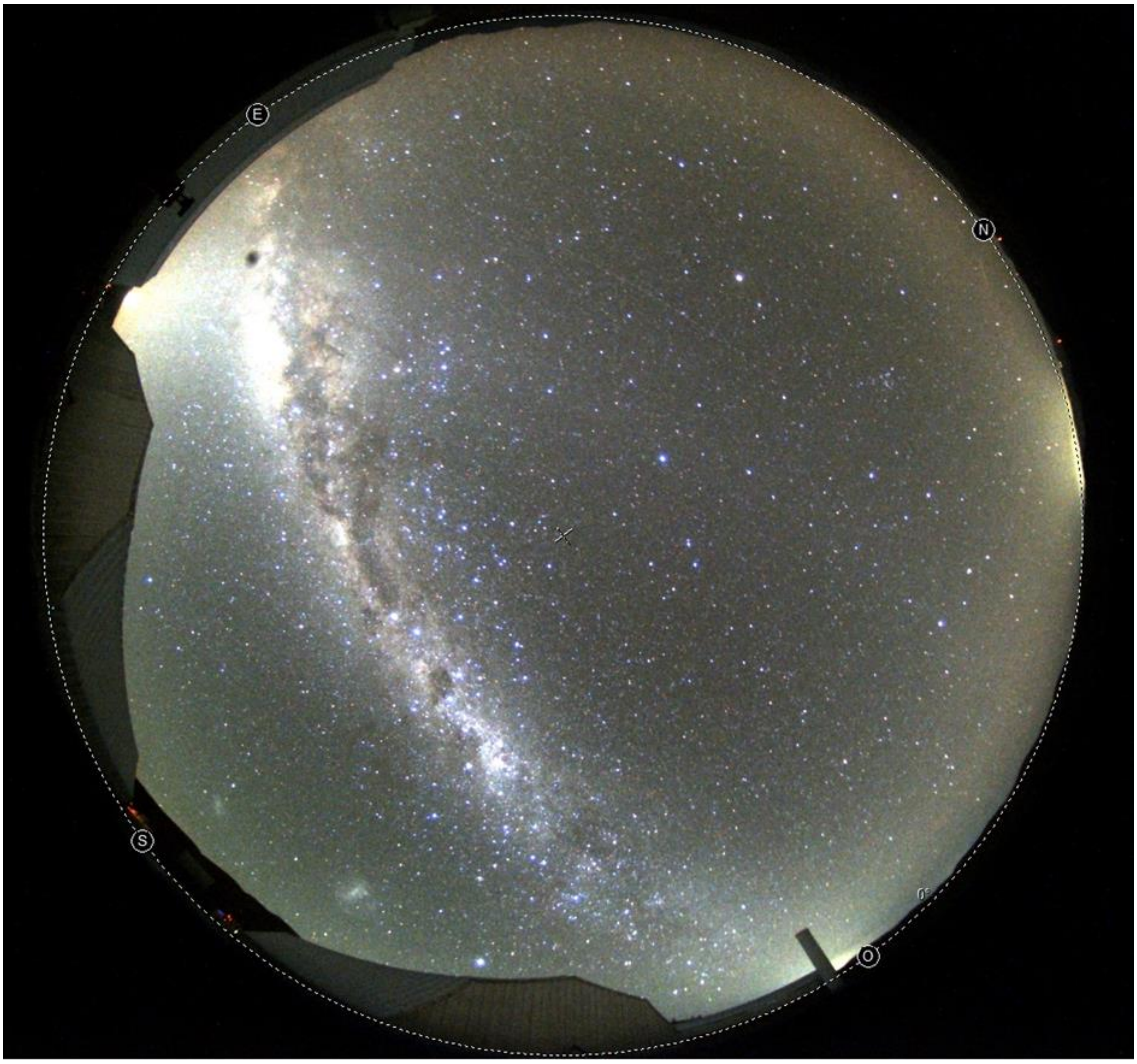
T CrB

Please keep monitoring the recurrent nova in the run up to its next eruption. It is now becoming easier to observe in the Spring skies.

Prof. Bradley E. Schaefer's (Department of Physics and Astronomy, Louisiana State University) prediction for the eruption is 2024.4 ± 0.3, i.e. 2024 February to August. We are now within that window. On the other hand, this prediction assumes that the pre-eruption light curve this time round will be the same as its 1946 eruption. Perhaps this time it will be different and there is already a suggestion that this might be the case, so keep looking! I am really hoping an amateur astronomer will be the first to spot the eruption. Wouldn't it be great if it were a VSS observer?

Mike Harlow is trying a different approach to detecting the eruption. Given the incessant cloud the UK seems to be experiencing, he is using the iTelescope all-sky cameras to monitor it. An image from the iTel site in Chile is shown below. Mike comments that "when it does erupt again an animation of a series of all-sky shots on consecutive days would be quite interesting".

More on T CrB later in this Circular….



All-sky camera view from the iTelescope site in Chile, 2024 Feb 15. Corona Borealis is located near the top of the image. (Mike Harlow)

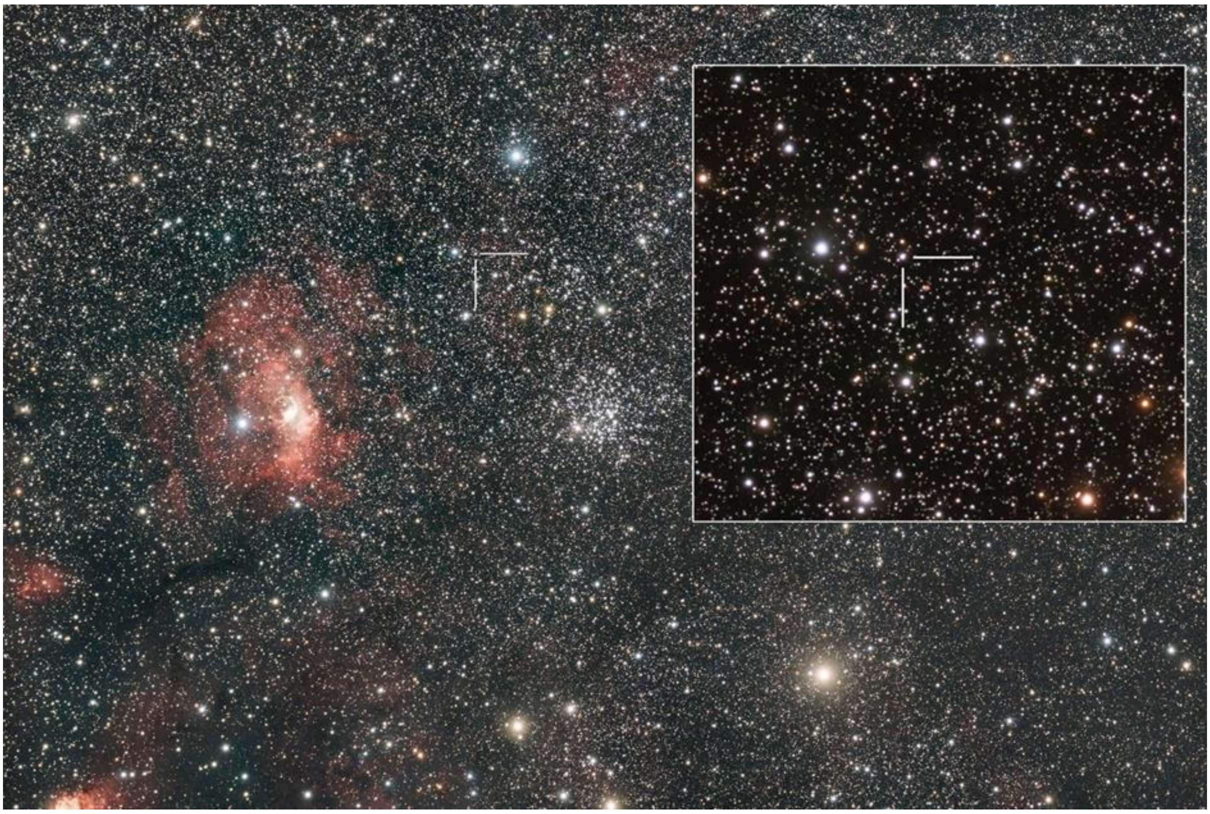
Observing UGER systems

Don't forget the campaign, coordinated by Stewart Bean, to detect outbursts of UGER-type dwarf novae. These are frequently outbursting systems and the aim is to study variation of their supercycle lengths – the time between successive superoutbursts. Targets include **ER UMa** itself, **IX Dra**, **RZ LMi**, **V1159 Ori**, **YZ Cnc** and **DI UMa**.

V1405 Cas

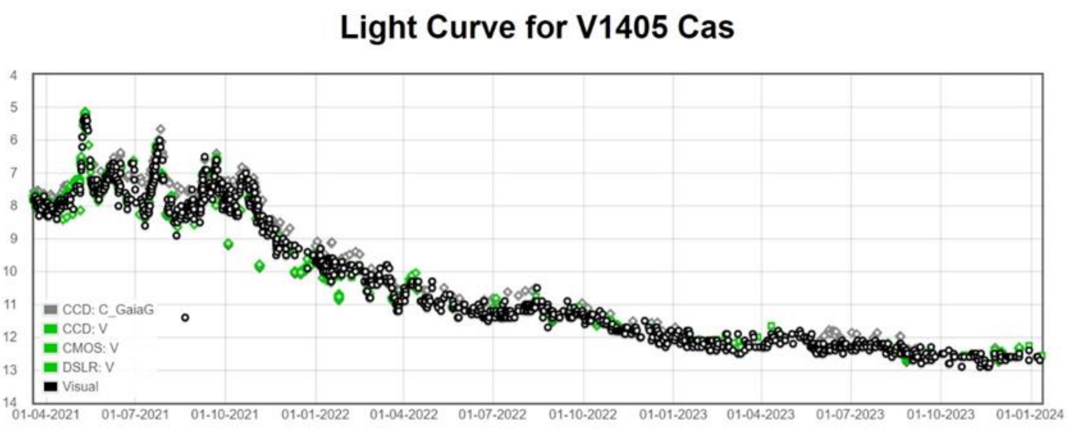
March 18 will be the third anniversary of the discovery of Nova Cas 2021 (V1405 Cas). It is still active at ~mag 12.7 and being followed by several observers.

Mazin Younis has imaged the field many times over the last three years and one of his fine images graces the 2024 BAA calendar. His latest image was on Jan 2 from his remote observatory in Morocco.



V1405 Cas and the nearby Bubble Nebula, 2024 Jan 2 (Mazin Younis)

Field 2°24' × 1°37'. Equipment: Esprit 100ED Pro refractor, ASI 2600MC camera. Exposure: 30 x 500s



Contributors: P G Abel, S W Albrighton, C Anderton, D Boyd, D S Conner, D Dobbs, C J Evans, G Fleming, R B I Fraser, K Gurney, D Hufton, G M Hurst, N D James, M L Joslin, D Matthews, M Mobberley, R Pearce, G Poyner, J D Shanklin, J Shears, J Toone, T Vale, I L Walton, P B Withers

Back to contents

Discovery of a nova super-remnant cavity surrounding RS Oph

RS Oph last erupted in 2021 August. An MNRAS preprint on ArXiv (https://arxiv.org/abs/2402.05855) describes the discovery of a nova super-remnant (NSR) cavity surrounding RS Ophiuchi. The team from Liverpool John Moores University and the Royal Observatory Edinburgh used archival FIR images from IRAS.

An NSR is a vast extended shell surrounding a recurrent nova (RN) formed by the cumulative effect of eruptions sweeping up local interstellar medium. It is speculated that all RNe should result in an NSR, but the only other one confirmed so far is that associated with M31N 2008-12a, in the Andromeda Galaxy, which is the most frequently erupting RN.

The remnant of another RN, **T Pyx**, has also been in the news. An MNRAS submission was posted on ArXiv titled "3D physical structure and angular expansion of the remnant of the recurrent nova T Pyx": https://arxiv.org/abs/2402.07879. The remnant has a bipolar structure. The expansion velocity is ~460 km/s.

Newly identified period bouncers

Period bouncers are cataclysmic variables that have evolved down to the period minimum and whose orbital periods are now increasing. Relatively few period bouncers are known and a few more are suspected. Likely period bouncers include WZ Sge and V455 And. In a recent submission to A&A (https://arxiv.org/abs/2401.17298), researchers in Germany confidently identify 5 additional strong period-bounce candidates, bringing the total to 22. Four of these 5 systems (RX 1050, SDSS 1216, EG Cnc, and HV Vir) had already been suggested as potential period-bouncers. The remaining system, SDSS 1219, was mentioned in the literature as a WZ Sge-type system.

These are, or are expected to be, very infrequently outbursting objects that might be worth monitoring.

The lead author, Daniela Muñoz Giraldo, has kindly provided me with the sull SDSS catalogue name for RX 1050, SDSS 1216, SDSS 1219, these being SDSS J105010.65-140436.7, SDSS J121607.03+052013.9, SDSS JJ121913.06+204937.6 respectively. It turns out that the latter has been on my observing list for many years.

High resolution images of R Lep

R Lep is a carbon star which appears distinctly red. It is named after British astronomer J. R. Hind, who observed it in 1845 and is sometimes called Hind's Crimson Star. It has a range of 5.5 - 11.7 V.

In a recent ApJ paper a team from the Atacama Large Millimeter/submillimeter Array (ALMA) describes how they obtained images of R Lep with a resolution of 5 milliarcseconds. These showed continuum emission from the star's surface which is surrounded by ejected gas revealed by HCN maser emission.

For further information, see Indra Bains' article in the February BAA *Journal*, page 5, and the ApJ pre-print at: https://arxiv.org/abs/2310.09664.

c Puppis

c Pup is an irregular variable of spectral type K4 but has <0.1 mag amplitude so I doubt if it is much observed! I hadn't come across this star until I saw another fine image by Mazin Younis taken remotely from Morocco. This shows NGC 2451 which is one of the brightest open clusters in the southern hemisphere. The bright orange star is c Puppis, which is surrounded by hot bright stars, set against a patch of HII region. I thought this was worth sharing.

c Puppis and NGC 2451 (Mazin Younis)

Field: 2°24' × 1°36'. Equipment: Esprit 100ED Pro refractor.
ASI 2600MC camera + UV-IR filter. Exposure: 20 x 300s

Cover Picture. R Aquarii

Peter Goodhew writes…

R Aquarii is a symbiotic binary surrounded by a large and complex nebula known as Cederblad 211 with a prominent curved jet.

This nebula is roughly 650 years old. R Aquarii is believed to contain a white dwarf and a Mira-type variable in a binary system. The orbital period is approximately 44 years.

The giant primary star is a Mira variable, a star that pulsates and changes temperature, leading to very large visual brightness changes.

In total it varies in brightness by a factor of 750, and with a period of 390 days.

The central region of the jet shows an ejection that took place around 190 years ago, as well as much younger structures.

Until recently all images of the whole system have been predominantly red. This is because it is situated in a very dusty region of space, and its blue light is absorbed before reaching Earth.

However, in 2018 Australian amateur Mike Sidonio discovered previously unknown faint outer [OIII] features from his Terroux Observatory near Canberra, Australia (https://pbase.com/strongmanmike2002/r_aquarii).

Despite these detections, no clear imaging of these features has been produced to date.

I therefore decided, with help from fellow amateur Sven Eklund, to conduct deep imaging using [OIII] filters from our remote observatories in southern Spain.

This revealed hitherto unseen features extending beyond the known scope of Cederblad 211.

The image was captured using two APM TMB LZOS 152 Refractors, plus a Celestron EdgeHD 14" SCT.

A total of 58 hours 30 minutes of imaging time resulted in this image.

The Curious Case of the Recent Transient AT2023yjq

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Firstly, it is not a transient, but is variable between G = 18–21, on a time-scale of a few hundred days. Secondly, it is a known variable radio source, and has a mid-IR excess, is an X-ray and likely gamma-ray source, and has already been classified as an active extragalactic object. Finally, a recent spectrum shows zero redshift so if it is a stellar source then it is most likely a magnetic CV.

On November 27th last year Hodgkin et al. (2023) reported the discovery of the new transient AT2023yjq in the Gaia data at $G = 18.09 \pm 0.2$. It was noted as an erratic source that had brightened by 1 magnitude and was coincident with a radio source. Two days later it was classified spectroscopically as a variable star (Kopsacheili et al., 2023) with clear Hα absorption, at zero redshift, and is already listed in the AAVSO VSX (Watson et al., 2006). In fact, the object had already been catalogued in the optical, albeit at magnitude 19–20, in the NOMAD Catalog (Zacharias et al., 2004), GSC 2.3 (Lasker et al., 2008) and subsequent versions, and other astrometric catalogues, most recently in Gaia DR3. The association with a radio source was also well documented with observations at multiple frequencies and epochs, and it was already known as a variable radio source at 1.4 GHz (Ofek & Frail, 2011). It is also catalogued by WISE in the mid-IR where it appears unusually bright at 22 μm (Cutri et al., 2021). At shorter wavelengths it is listed in the live Swift catalogue as LSXPS J062108.7-255757 (Flesch, 2023), and it lies 223 arcsec from the γ-ray source 2FGL J0621-2557 (see e.g., Nolan et al., 2012, Massaro et al., 2013).

The association of the object with γ-ray, X-ray, variable radio and infra-red excess sources has led to its interpretation as an active extragalactic object, either a Blazar, QSO or AGN, and it has found its way into many such catalogues in VizieR. The galactic coordinates of $l = 234$ and $b = -18$, being out of the plane and away from the galactic centre do not immediately suggest a galactic origin. The Gaia DR3 parallax is $\pi = -0.30 \pm 0.20$ mas, so the distance is technically indeterminate, however, based on their interpretation of the Gaia EDR3 data Bailer-Jones et al. (2021) suggest an accessible distance of $d \sim 4$–8 kpc, leading to a distance from the galactic plane of 1.3–2.6 kpc.

Although faint, the object is within the range of the Asteroid Terrestrial-Impact Last Alert System (ATLAS) project (Tonry et al., 2018), and the Zwicky Transient Facility (ZTF) (Bellm et al., 2019, Masci et al., 2019), that provide observations from 2016. Nearly 3000 usable observations are available in the ATLAS 'cyan' *c* (420–650 nm), and 'orange' *o* (560–820 nm) bands and are taken from the ATLAS Forced Photometry web service (Shingles et al., 2021, Smith et al., 2020). Typically, five or more observations are made in quick succession, but at this magnitude the uncertainties are usually $0^m.2$–$0^m.6$ or larger, and discordant measurements are not uncommon. To construct the most reliable light-curve the observations with internal errors in excess of $1^m.0$ have been rejected, and nightly means have been constructed from the remaining data. A very much smaller number of observations are available from the ZTF, with 107 in Sloan *g* (414–546 nm), and just 5 in *r* (566–721 nm). Where possible nightly means are also used. The ZTF *g* and *r* bands are effectively coincident with the shorter wavelength halves of the ATLAS *c* and *o* bands respectively. The ATLAS and ZTF data are shown in Figure 1 and demonstrate coherent variations between magnitude 18 and 21 on a time-scale of a few hundred days, but there is no compelling evidence of any outburst activity, and in fact the density of observations suggests that the object is very rarely brighter than magnitude 18.

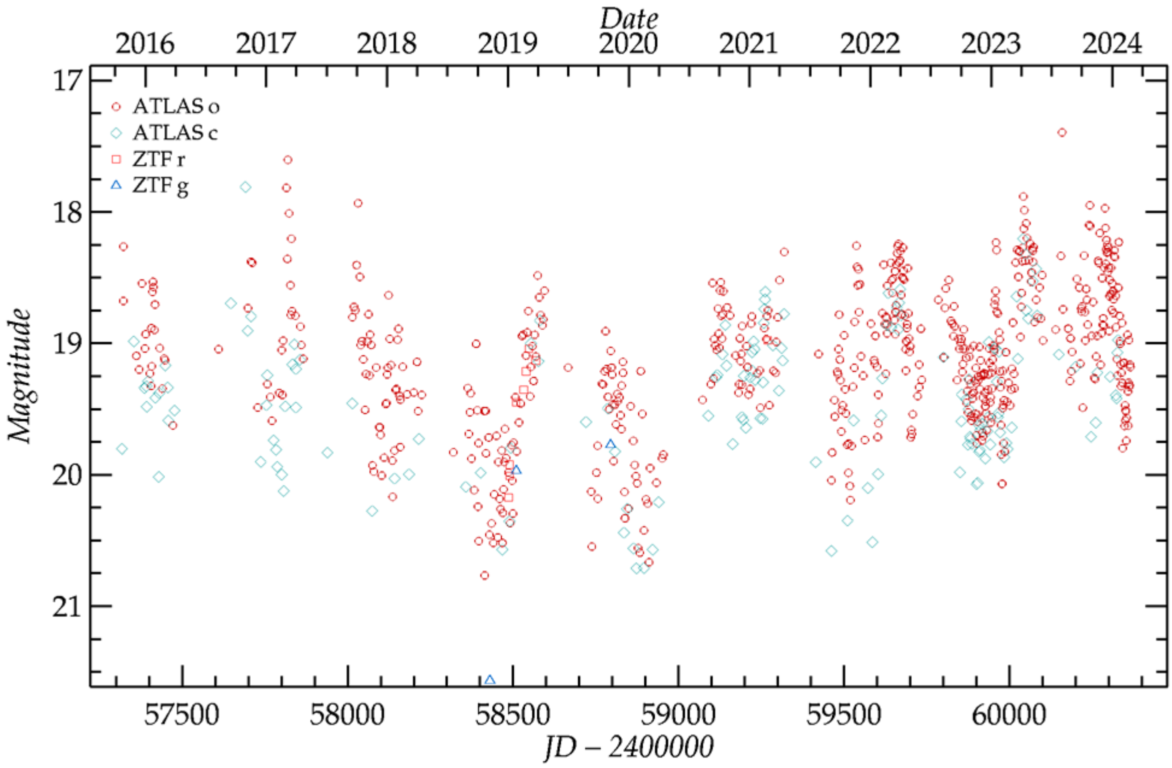

Figure 1: Epoch plot of the daily mean magnitudes of the ATLAS *o* and *c*-band and the ZTF *g* and *r*-band data. There are very few ZTF *g* observations and the vast majority of the ZTF *r* data were taken in 2019. The coincidence of the different bands suggests that the object is relatively blue.

The Gaia photometry is available from 2014, and the alerts are based on this, but the published photometry only covers about 2½ years up to early 2017. The Gaia light-curve is very similar to the ATLAS data, with mean magnitudes of $G = 19.8\pm0.7$, $G_{BP} = 19.9\pm1.4$, and $G_{RP} = 19.1\pm1.1$, but there is a more obvious difference between the bands giving $(G_{BP} - G_{RP}) \sim 0.8$. There are only about 60 epochs and no clear evidence of outbursts. A similar number of observations are also available from the Catalina Sky Survey (Drake et al., 2009), from 2006–2010 with a mean of $V = 19.1\pm0.5$, and no observations brighter than magnitude 18.

Assuming for a moment that the object is galactic and that the distance is 4 kpc, and further assuming no extinction, then with $G = 19.5$, the absolute magnitude $M_G = 6.5$. For a distance of 8 kpc then $M_G = 5.0$, and obviously for every magnitude of extinction the luminosity increases by one magnitude. Such a luminosity places the object in the realm of CVs, which cover a wide range from $M_G = 3$–11 (Mukai & Pretorius, 2023). Continuing this theme, the light-curve with its limited wandering and lack of outbursts is consistent with a magnetic CV. Such an object could be the origin of the X-rays observed (see Schwope et al., 2021, and references cited) and possibly the γ-ray emission as well (see e.g., Massaro et al., 2013, Pavlenko et al., 2013). The mid-IR excess emission could be from cool circumstellar dust, which is known to be present in CVs either in equatorial discs or more distant shells (see Dubus et al., 2004, Howell et al., 2006, Hoard et al., 2014). It is therefore possible to attribute all the observed properties of this object to a magnetic CV, however, the likely distance from the galactic plane is an uncomfortable consequence. While the previous interpretation that this object is an active extragalactic source is entirely consistent with the observations, the recent spectrum with Hα absorption at zero redshift should definitively point to a stellar origin, and a magnetic CV could meet all the other requirements.

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T CrB Charts and Sequences 1946-2024

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The evolution of the BAA VSS and AAVSO charts and sequences for T CrB since 1946 is summarised.

Following the eruption of 1946 which established T CrB as the brightest recurrent nova, both the BAA VSS and AAVSO produced finder charts with standard comparison stars that ushered in the period of systematic monitoring by amateur observers that still continues today. This article provides an outline description of the evolution of the T CrB charts and sequences since 1946.

The sequences including comparison stars below magnitude 7 contained on the BAA VSS and AAVSO charts released since 1946 for T CrB are summarised in Table 1. Each comparison star is identified by a common star catalogue reference together with their V and B-V values and are listed in descending order of brightness.

Star ID	V mag	B-V	NFHK1946	NFHK1946	WML1946	WML1946	AAVSO1946	JEI1970	JEI1970	JEI1972	JEI1972	025.01	025.01	AAVSO1986	025.02	025.02	025.03	025.03	025.04	025.04	AAVSO2024
HD144287	7.10	0.77			d	7.06	71	d	7.06	d	7.06	F	7.20	71	F	7.10	F	7.1	F	7.1	71
HD143393	7.11	1.15	48	7.21																	
HD145676	7.52	0.45	97	7.37																	
HD144004	7.67	0.57	75	7.69																	
HD143707	7.90	0.43	67	7.89	f	7.89	79	f	7.89	f	7.89	G	7.94	79	G	7.89	G	7.9	G	7.9	79
HD143455	7.89-7.94	1.48	9	7.96	g	7.96	80	g	7.96	g	7.96			78							
MS Ser	8.24-8.44	1.00	3	8.36	h	8.36	84	h	8.36	h	8.36	H	8.49	83							
HD143808	8.37	0.54												84	P	8.37	P	8.4	P	8.4	84
HD143329	9.22	0.96			m	9.36	94	m	9.36	m	9.36			94	R	9.22	R	9.2	R	9.2	
HD143161	9.24	1.57												94							94
HD143352	9.33	0.38			l	9.19		l	9.19	l	9.19	K	9.45	94							
SAO84123	9.71	0.55					91							97							
HD143211	9.74	0.87												99							98
HD143256	9.80	1.08			n	9.76	98			n	9.76	L	10.00	98	L	9.81	L	9.8	L	9.8	99
HD143128	10.29	0.55												102			S	10.3	S	10.3	
GSC 2037 1231	10.53	0.60			o	10.06	102			o	10.06	M	10.5		M	10.53	M	10.5	M	10.5	106
GSC 2037 1195	10.54	red												107							
GSC 2037 1130	10.78	0.51												107							108
GSC 2037 1228	11.19	0.65												112	N	11.30	N	11.2	N	11.2	112
GSC 2037 1416	12.37	0.71																	W	12.4	124

Table 1: The comparison star sequences covering stars fainter than magnitude 7 used by the BAA VSS and AAVSO during the period 1946-2024. The columns are in date order and the rows are in descending order of brightness. There are two columns for each BAA VSS chart giving the star identification and the magnitude. For the AAVSO charts there is a single column which provides the magnitude with the decimal point omitted (standard practice on AAVSO charts).

The earliest chart in the BAA VSS archives was drawn by N F H Knight (co-discoverer of the 1946 eruption) on 12 February 1946 whilst the star was fading from the eruption that he had detected just three days earlier [1]. This consisted of two field charts (Figure 1) covering the naked eye and binocular views and listed comparison stars to magnitude 8.4. The first official BAA VSS charts were prepared by W M Lindley just two days later and they included comparison stars down to magnitude 10.06 which remained the standard sequence until 1980. Throughout the period 1970-2023 there were six revisions of the charts and the sequence has been extended to magnitude 12.4 on the V photometric scale. Prior to 1972 the comparison stars were identified by lower case letters but in 1980 (chart ref 025.01) they were replaced by capital letters.

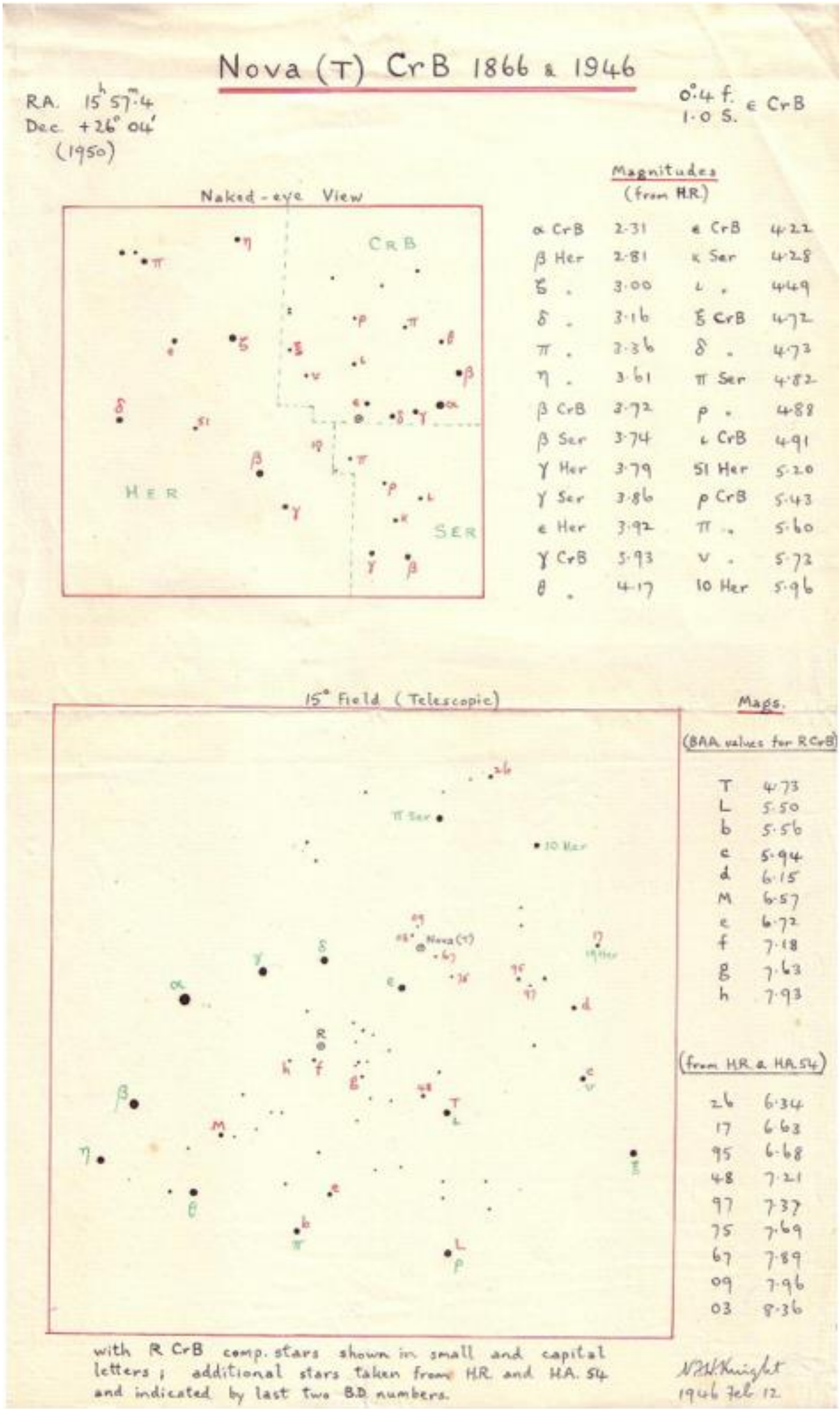

Figure 1: N F H Knight's chart drawn just three days following his detection of the 1946 eruption of T CrB. The comparison stars fainter than magnitude 7 have been included in Table 1.

The original AAVSO chart dated 1946 included comparison stars largely adopted from the Revised Harvard Photometry (RHP) catalogue (rounded to one decimal place) to a magnitude limit of 10.2 and this was still in use (with amendments in 1981 & 1986) in 2001. The current charts that can be downloaded from the AAVSO chart plotter extend the sequence to below 13th magnitude on the V photometric scale.

Examination of the listed magnitudes in Table 1 indicates that the majority of the comparison stars have remained quite stable with minimal changes. The fact that both the BAA VSS and AAVSO adopted RHP catalogue values (from HCO Annals Vol 54) when preparing the 1946 sequences was fortuitous because in comparison to modern V photometry, they are closely aligned and linear. However, there are issues involving two non-HD stars; namely SAO84123 and GSC 2037 1231.

SAO84123 was assigned a magnitude of 9.1 on the 1946 AAVSO chart that was corrected on the later charts (from 1981) to magnitude 9.7. This star was never used on BAA VSS charts and only presents a minimal risk to the AAVSO data because it was not likely to have been used much given that there are more convenient comparison stars closer to the variable.

GSC 2037 1231 is a more significant case because for many years it was the faintest star in both the BAA VSS & AAVSO sequences and it has been used extensively to estimate T CrB whilst the star has been at minimum light. The original magnitude assigned by the BAA VSS in 1946 was 10.06 which was based on a visual estimate by W H Steavenson [2]. This was amended to 10.5 in 1980 on chart ref 025.01. This means that the range quoted in the discovery of the ellipsoidal photometric variations from BAA VSS visual data in 1961-1970 [3] is understated.

The original magnitude assigned to GSC 2037 1231 by the AAVSO in 1946 was 10.2 and this value was used in Burnham's Celestial Handbook in 1978 and David Levy's Observing Variable Stars A guide for the beginner in 1989. The star was dropped on the 1986 chart revision but was reinstated sometime after 2001 and the current given value is 10.6.

The reduced magnitude gap between GSC 2037 1231 and the brighter HD143256 (the two comparison stars most extensively used) that existed for many years has acted to suppress the apparent variation of T CrB at minimum light. This is an important factor that researchers should consider when analysing visual observations in the BAA VSS and AAVSO databases. Fortunately, where the original light estimates are recorded in the BAA VSS database, that data can be re-reduced error-free.

Finally, Figures 2 and 3 reproduce the current BAA VSS charts to be used when T CrB next erupts. Since that eruption is predicted to be imminent it is recommended that these charts are pinned to everyone's observatory walls.

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2. 1932 MNRAS Vol 92, Pages 720-721

3. 1975 JBAA Vol 85, Pages 217-223

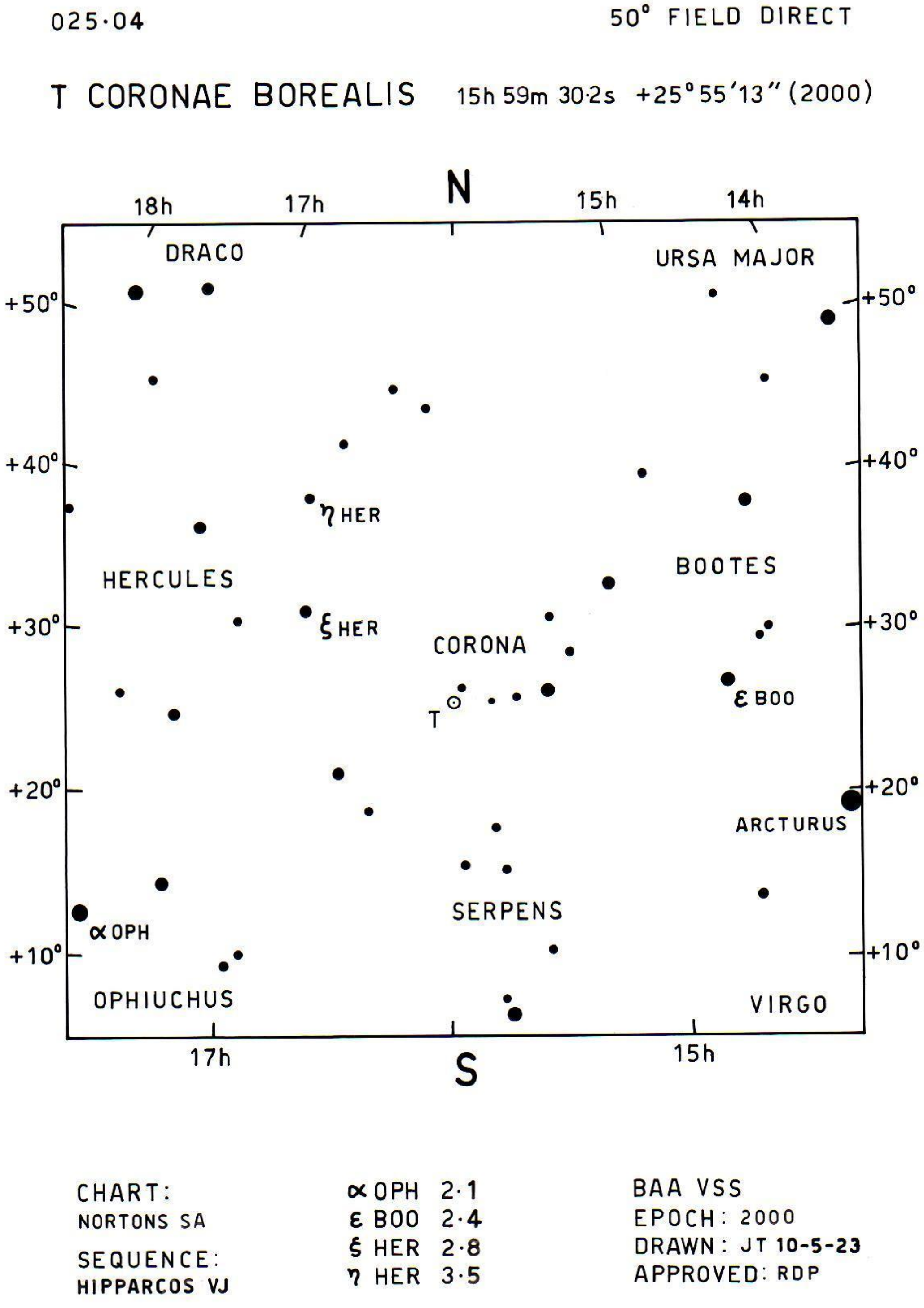

Figure 2: Fifty-degree BAA VSS chart which can be used when T CrB is brighter than magnitude 4.

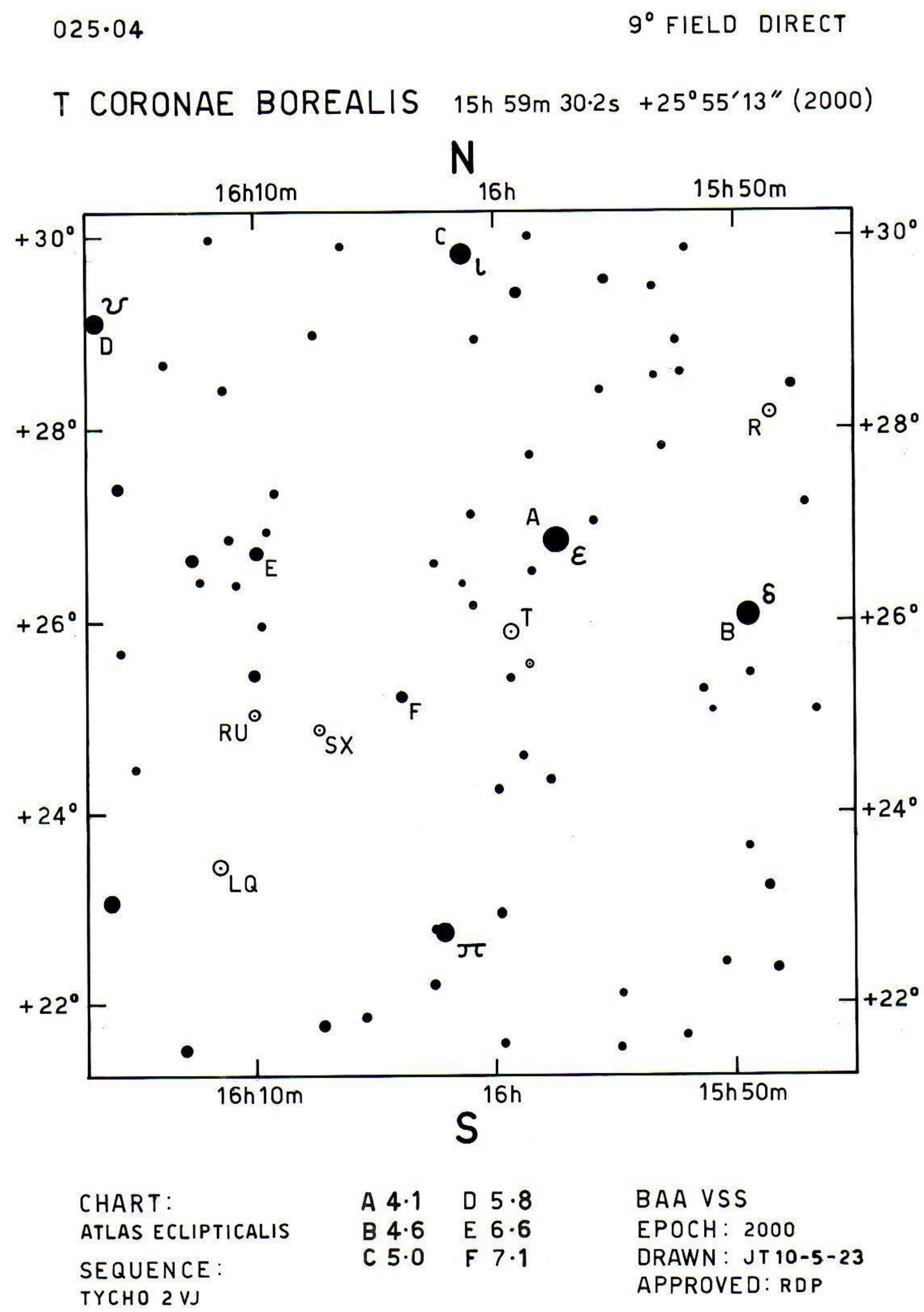

Figure 3: Nine-degree BAA VSS chart which can be used when T CrB is between magnitudes 4 and 7.

Leslie Peltier's Observations of T CrB in 1920-1945

John Toone

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A short desktop investigation into Leslie Peltier's observations of T CrB throughout 1920-1945.

By all accounts Leslie Peltier was an outstanding observer who discovered 12 comets and submitted 132,000 visual observations of variable stars to the AAVSO [1]. Back in 1999 one of the few people who knew him (apparently Peltier was something of a recluse) Tom Cragg, told me that Peltier was probably the best visual observer that America had ever produced.

Peltier was an avid observer of T CrB before it was known that it was a recurrent nova and it is on record that he recorded enhanced variation prior to the eruption in 1946. I was surprised therefore to read that Bradley Schaefer did not include Peltier's observations in his long-term light curve of T CrB on account of discrepancies with other observers' data [2]. Given Peltier's impeccable reputation as an observer, I thought that it was worth looking at his observations to see if there was any obvious reason why they were discrepant.

I did not have time to do an exhaustive search of all relevant documentation so I restricted the investigation to a desktop examination of Peltier's observations accessible from the AAVSO database in comparison with the star catalogue photometry available prior to 1946.

Upon review of Peltier's observations, it was immediately apparent there was a step change of 0.5 magnitude in October 1932. Between 15 July 1920 & 30 Sep 1932 the observations ranged 9.0-9.5mv with an average of 9.3mv. Then abruptly from 21 Oct 1932 through to 15 Mar 1945 the observations averaged 9.8mv with only minimal deviation. A step change might occur if T CrB was entering a high-state but this was the opposite behaviour, a sudden reduction in brightness. This was a strong indicator to me that Peltier had changed his sequence in Oct 1932.

When Peltier commenced observations of T CrB in 1920 the two principal catalogue sources available for potential comparison stars were the Bonner Durchmusterung (BD) and the Revised Harvard Photometry (RHP) [3]. A comparison of the magnitudes from the BD & RHP for the most likely comparison stars used by Peltier is given in Table 1.

Star ID	BD mag	RHP mag	Difference
HD143352	8.8	9.19	0.39
HD143329	8.9	9.36	0.46
HD143256	9.1	9.76	0.66
		mean	0.50

Table 1: The three most commonly used comparison stars for T CrB that were included in both the BD and RHP catalogues. The catalogue magnitudes for each star are given together with their calculated differences. HD143329 & HD143256 were adopted as the 94 & 98 comparison stars on the first AAVSO chart produced in 1946.

As can be seen in Table 1 the average difference between the two catalogue sources is 0.5 magnitude which is precisely the difference in mean magnitude observed by Peltier before and after October 1932. It is notable that the average magnitude of 9.8mv is the same value as the RHP value of the most extensively used comparison star HD143256. I therefore conclude that Peltier was originally using a sequence drawn from BD values but in Oct 1932 he switched to RHP values and on most subsequent occasions estimated T CrB as equal to HD143256.

Therefore, for any future analysis of Peltier's T CrB data, I would recommend applying an adjustment of 0.5 magnitude to those observations made prior to October 1932.

Since it is reasonable to assume that Peltier used HD143256 as his principal comparison star adopting a magnitude of 9.8 and that the modern value for HD143256 is also 9.8 (Tycho 2 catalogue value), we can be confident that Peltier's 1945 data can be directly compared with visual data accrued using the BAA VSS chart in 2023. Such a comparison is worth making because 1945 was the year when Peltier recorded enhanced variation (primarily a fade) just ahead of the 1946 eruption and 2023 was the end of high-state activity ahead of the next predicted eruption in 2024 [4].

Accordingly, Figure 1 presents the light curve of T CrB in 1945 by Peltier superimposed upon 2023 observations made by myself.

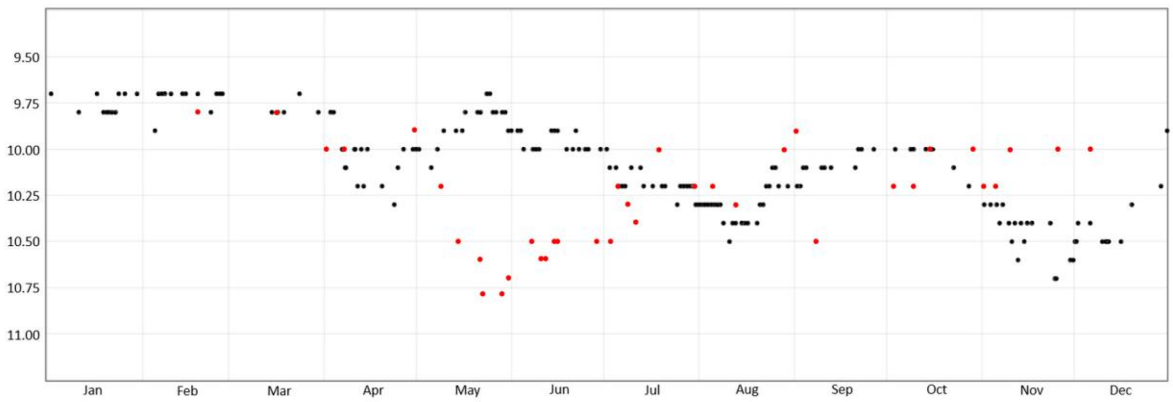

Figure 1: Light curve of Peltier's observations of T CrB in 1945 (red dots) superimposed on my observations (black dots) in 2023. For the 1945 observations it is assumed that Peltier used HD143256 (9.8) as the sole comparison star. The 2023 observations used HD143256 (9.8) & GSC 2037 1231 (10.5) as comparison stars in accordance with BAA VSS sequence 025.04.

In 1945 Peltier recorded enhanced variations including a one magnitude fade to 10.8mv in May. The star had partially recovered by July and the rest of the year it fluctuated over a small range with a lower mean value of 10.1mv.

In 2023 there have been well defined (0.6 magnitude range) ellipsoidal variations with an overall decline in mean brightness. The ellipsoidal variations ranged 0.3-0.7 magnitude prior to the high-state activity commencing in April 2015 [5].

On the combined light curve Peltier's 1945 fade does not look majorly different to the ellipsoidal minima recorded in 2023. It's worth mentioning that it would have been a challenge for Peltier to accurately estimate T CrB using a comparison star that would have been around one magnitude different because step estimates that add up to more than 0.5 magnitude become increasingly difficult.

Back to contents

In conclusion the principal findings of this short investigation are:

1. Peltier changed his sequence in 1932 introducing a step change in his data.
2. The sequence limit was magnitude 9.8 (HD143256) and Peltier considered that to be the normal brightness of T CrB at minimum.
3. The fade recorded by Peltier in 1945 could be consistent with a deep ellipsoidal minimum (I will leave that for others to check the ephemeris) not unsimilar to those seen in 2023.

Important Note: The principal findings given here should be re-evaluated if an experienced visual photometrist has the opportunity to investigate Peltier's original light estimates and sequences used in his observations of T CrB.

References

1. 1999 Starlight Nights, Foreword by David Levy

2. 2023 MNRAS Vol 524, Pages 3146-3165

3. 1908 ANHAR Vol 54

4. 2023 VSS Circular 196, Pages 8-9

5. 2016 VSS Circular 169, Pages 6-9

A British independent discovery of the 1946 eruption of T CrB

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A discussion of the circumstances surrounding an independent discovery of the 1946 eruption by Michael Woodman, a schoolboy from Newport, South Wales

In the 2023 December VSS Circular 198, Tracie Heywood drew attention to a paper by BAA member N. F. H. Knight which appeared in the 1946 April BAA *Journal*, one of the first observers to spot T CrB in eruption on the morning of 1946 February 9.

The same edition of the *Journal* includes a report of the BAA Ordinary Meeting held on Wednesday, 1946 February 27, at Burlington House, London. A note was read by the Secretary on behalf of W.M. Lindley, VSS Director, which outlined some details of the eruption discovery. The President, P.J. Melotte, then invited Mr Knight to present his paper on his independent discovery. Norman Knight would not have had too far to travel to the meeting from his home at Bedford Park, Chiswick.

Norman Knight was an active VSS observer. He has 7,220 observations in the VSS photometry database made between 1936 December 5 (R Gem) and 1987 November 20 (R Sct).

However, the meeting report includes an intriguing addendum by Lindley about his note:

> *At the time of writing the above note the Director was unaware that priority of discovery had been officially accorded to M. Woodman of Newport, to whom the credit and congratulations for earliest discovery must thus go. This in no way detracts from Mr. Knight's independent discovery and prompt action.— W. M. L.*

When I spoke on T CrB at the 2023 June BAA meeting I referred to these two independent discoveries by Knight and Woodman. Shortly afterwards, I was contacted by Bill Barton, Deputy Director of the BAA Historical Section, who had attended my talk. He had managed to find a report about the Woodman discovery printed in the *Daily Mirror* Newspaper of Tuesday 12 February 1946 (p.4 & 5), which he transcribed thus:

> ***Boy found star the experts hunted for years***
>
> *Killing midnight time waiting for his father to come home from London, schoolboy Michael Woodman, aged sixteen stood at his bedroom window watching the stars.*
>
> ***Open on the window-ledge was his library copy of "Popular Guide to the Heavens" - the book that has cost his parents a bag full of pennies in library fines.***
>
> *He spotted one star that made him curious. He looked it up in the book three times, couldn't find it, and next day wrote to Sir Spencer Jones, the Astronomer Royal, asking him to explain how it came to be there.*
>
> *Sir Spencer did... in a broadcast.*
>
> ***He said that Michael's discovery is a star flare of the Corona Borealis, last located in 1866 and sought for ever since by astronomers.***

“I can’t believe it.” Michael said at his home in Queen’s Hill-crescent, Newport, Mon. last night, as he brushed away the drafts board in his excitement.

“The constellation of Corona Borealis was right opposite my window. I had to wait for Dad and since I don’t usually stay up so late I thought it a fine chance to do some stargazing without being told to go to bed.

“I noticed the dim star and tried to find it on the map. I got really excited when I saw on the map ‘Nova, 1866’ on the spot.

“I told Dad about it as soon as I saw him, but he pulled my leg and said ‘To heck with it, let’s get some sleep.’

“It was such luck. I was puzzled and as I didn’t know anyone to report it I wrote to the Astronomer Royal.”

“Michael took up star-gazing about three years ago.” his father told the Daily Mirror last night.

“He has tried to get me to do the same, but someone’s got to look where we’re going.”

Bill Barton goes on to note that a further report on page three of the *News Chronicle* of Tuesday 12 February 1946 indicates his father as being an inland revenue official and the discovery occurring around 01:45am. This report also states Michael’s age as 15.

Bill comments: “Given the above Michael would have been born around 1930 or 1931. There are several ‘Michael Woodman’ births for these years so it’s hard to know which one he was. Of course, is just possible he is still alive, although he would be in his early nineties by now.”

Many thanks to Bill for this very helpful follow-up investigation. If anyone else has any further information about Michael Woodman’s discovery, or about Norman Knight, I would be delighted to hear from them.

It is also interesting to note that at the same 1946 February BAA meeting, one of the speakers was “Dr E.M. Peachey” who presented a spectrum of T CrB taken on February 11 from the University of London Observatory (ULO) at Mill Hill. This was of course Eleanor Margaret Burbidge, FRS (née Peachey; 1919 –2020). Margaret Burbidge studied at University College London, where she received an undergraduate degree in 1939 and a Ph.D. in 1943. During the Second World War, she was caretaker at ULO, where she did her PhD research. Shortly after the war, she taught astronomy at ULO to undergraduate students from across the University of London. In 1951 she took a position at the Yerkes Observatory.

Recent observations of Mira variables on the BAAVSS programme. 2

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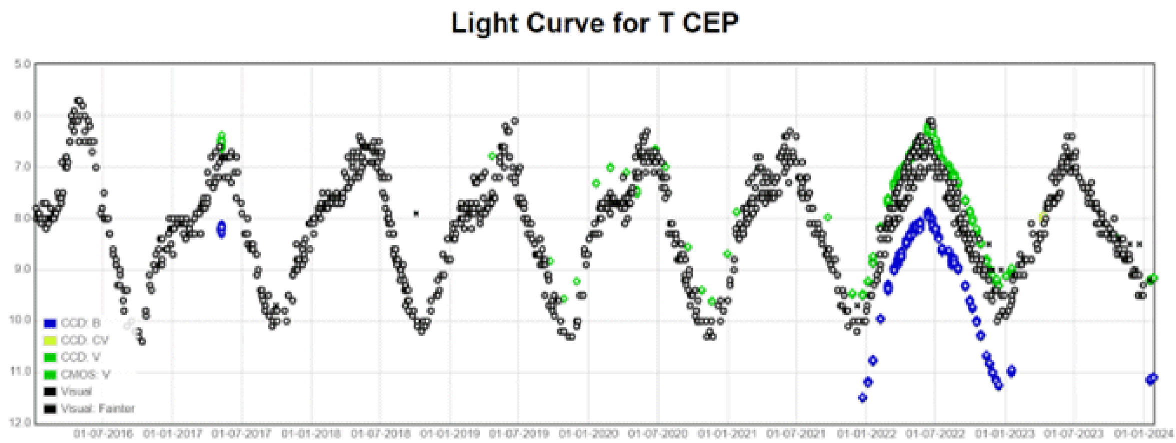
In this second part of a series of articles, we look at the activity of six Mira variables between 2016 and Jan 2024. Observations during this period show interesting behaviour, including pronounced humps on the ascending branch of T Cep and record maxima, in the case of S CrB.

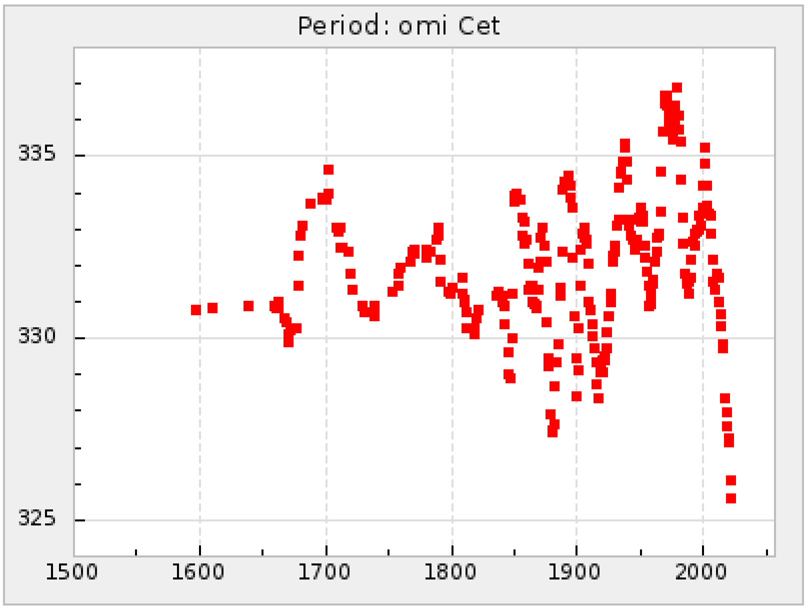
T Cep

VSX [1] lists T Cep as having a range of 5.2-11.0V, and a period of 388.9d. Unusually it takes 210d (54%) to rise from Min to Max. Spectra M5,5e – M8,8e. A plot of the star's period since discovery in 1788, show the period to range from 374d (current), to 402d around 1990. Observations plotted below show a reduced range of between 5.8 - 10.2. In addition, the star is clearly seen to display a hump on the ascending branch, apart from 2022 and 2023. In the case of the maxima occurring in 2021, the hump gives the impression of a double maxima.



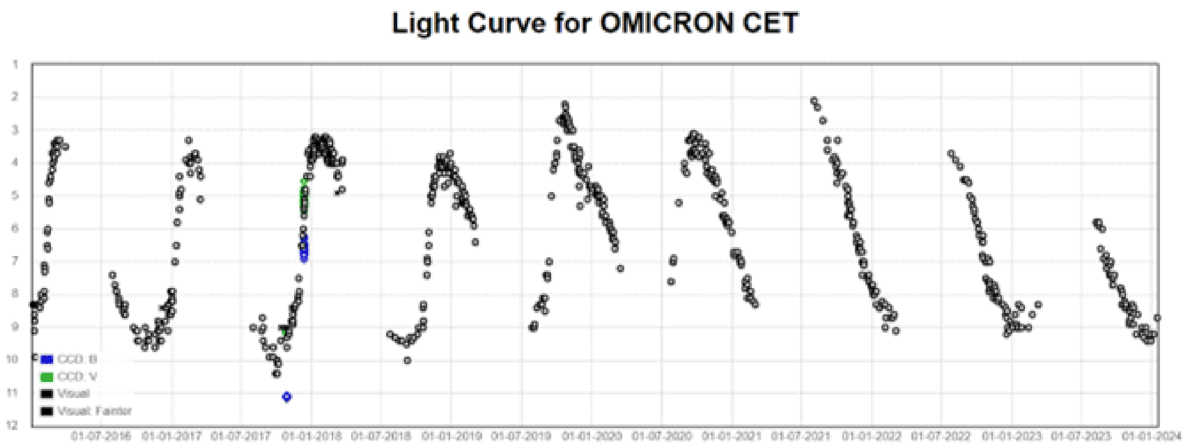
omicron Cet

VSX lists the star's maximum range as 2.0-10.1V, period 330.2d, 38% (125d) rising branch. Since its discovery the period has varied in the range of 326d to 337d, the value near to 326d being the current period, see period plot below [2].



Karlsson [2]

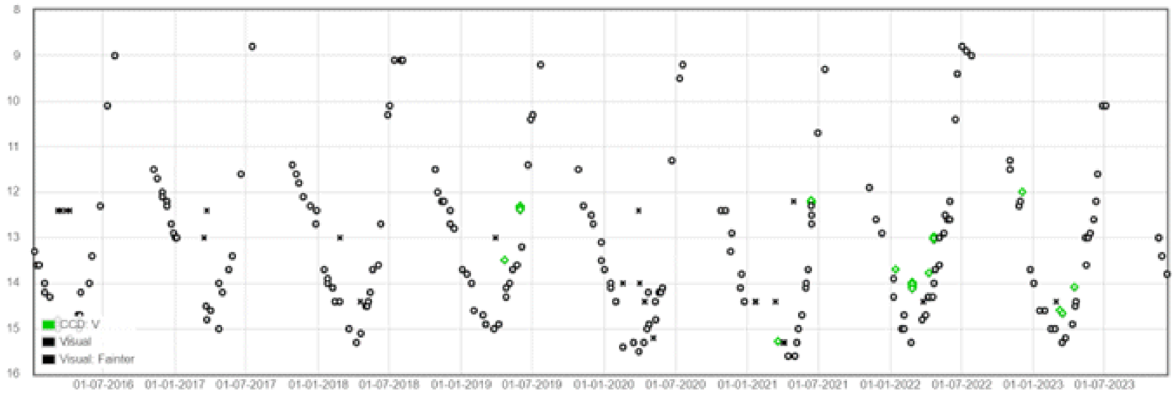
BAAVSS observations since 2016, are plotted below. Note the very bright maxima occurring in 2019 and 2021. Due to the star lying just south of the ecliptic it means that the star is difficult to observe from April to July, in particular for northern hemisphere observers.



R Com

VSX lists R Com has having a range of 7.1-14.6V, period 362.82d, 38% (137.87d) rise. Spectra M5e-M8ep. Having a period close to a year has meant that during the interval 2016 to date, maxima have been difficult, due to proximity to the Sun, however indications are that maxima appear fainter than VSX. In comparison, minima have been well observed, despite the faint visual magnitude of 15.0-15.7.

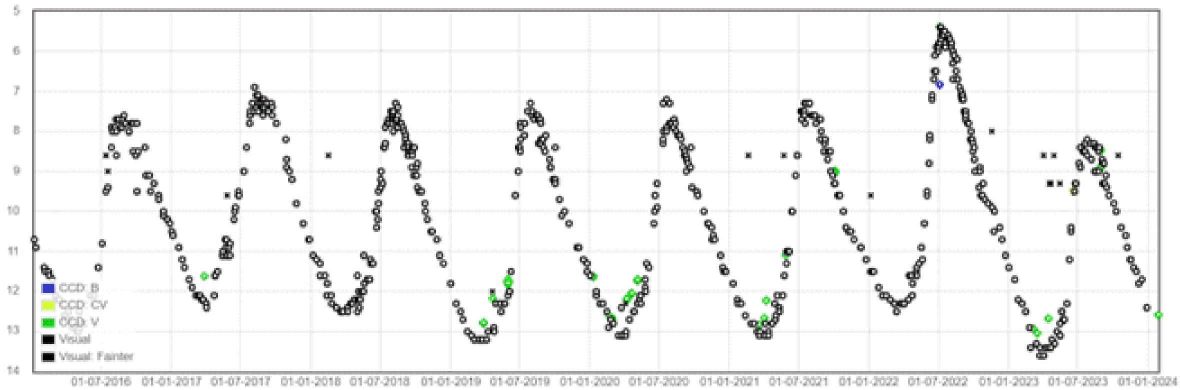
Light Curve for R COM



S CrB

S CrB is listed as having a range of 5.3-13.6V, period 360.26, rise 35% (126d), Spectra M6e-M8e. Period analysis shows only small variations of period between 356d-366d. Observations since 2016 are dominated by the record max in 2022 of 5.3. In addition, it is worth noting the deep minimum (13.6) and faint maximum (8.2) which followed.

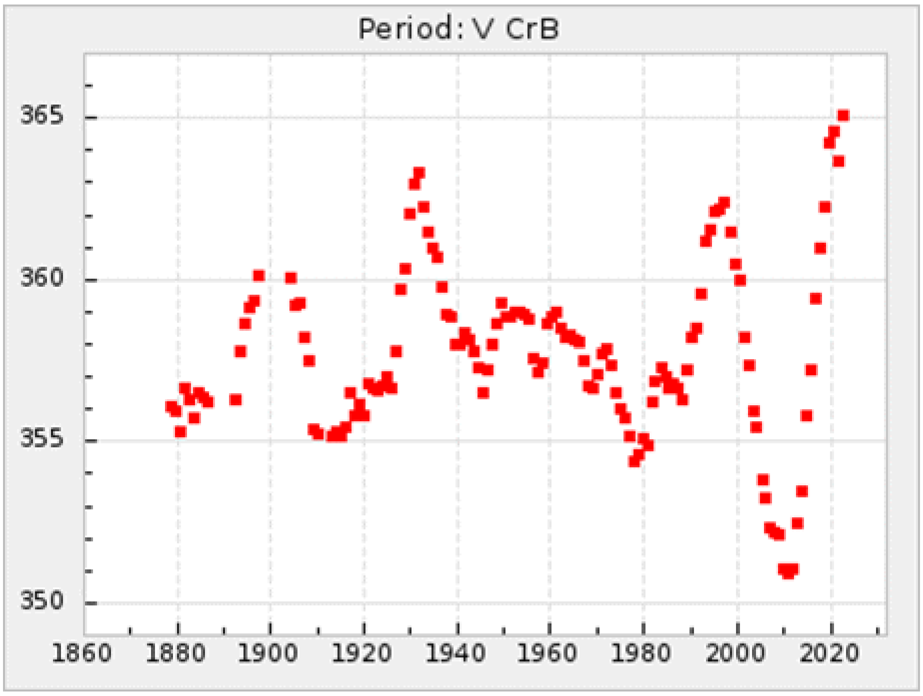
Light Curve for S CRB



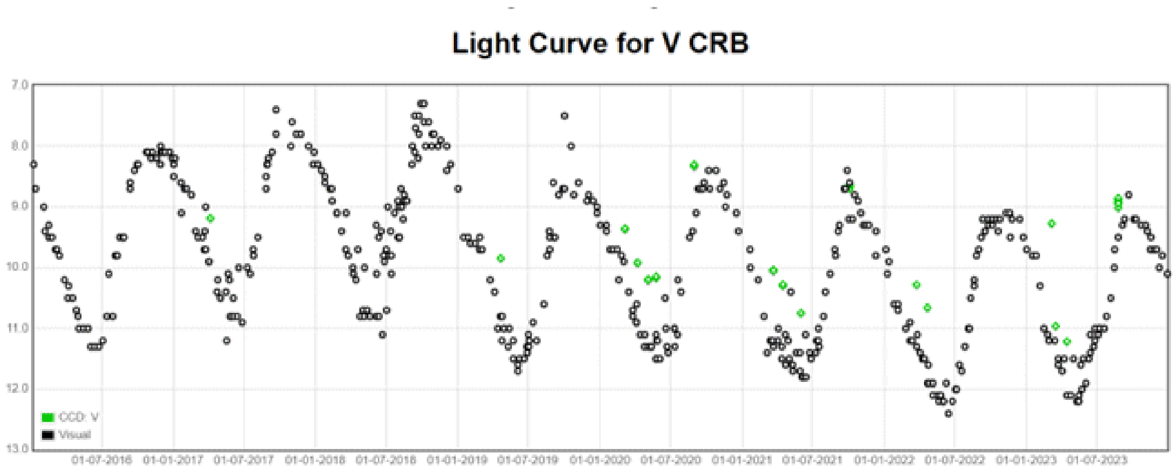
Back to contents

V CrB

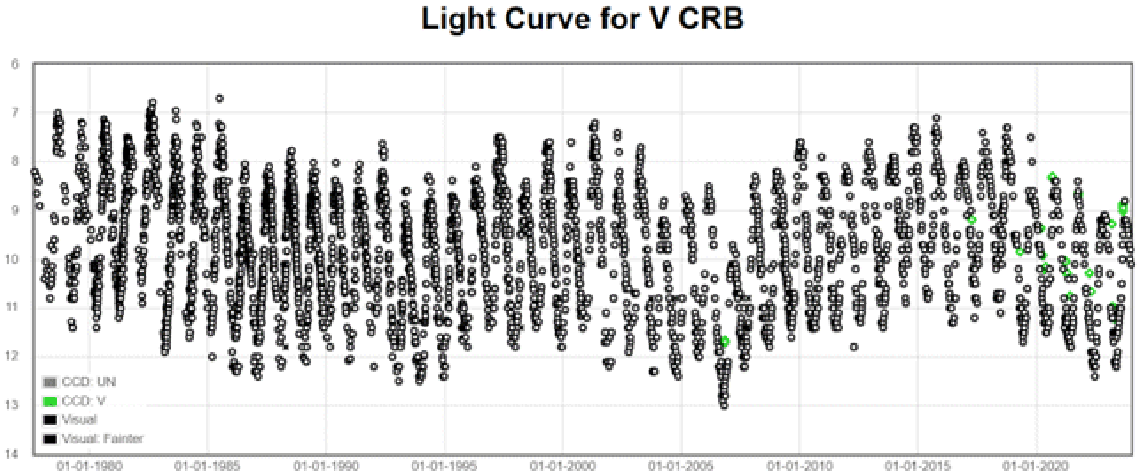
V CrB is listed as range 6.9-12.6, 357.4d, 41% (147d) rising, Spectra C6, 2e(N2e). Period analysis indicates a range of 351-365d, with it currently exhibiting its longest period.



Karlsson [2]

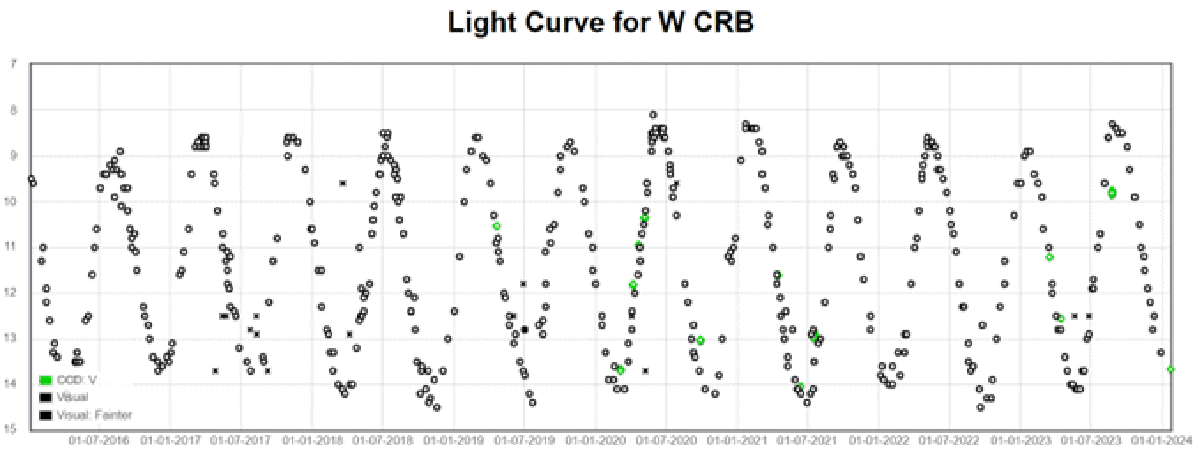


The plot of observations since 2016 confirms that V CrB does vary within the parameters of VSX, however this is the extreme range. As will be seen each cycle has a range of approximately 3.5 magnitudes, however the mean magnitude varies from cycle to cycle. Indeed, when we examine the observations since our records began in 1977, there appears to be a cyclical variation in the mean magnitude.



W CrB

VSX lists W CrB as, Range 7.8-14.3V, period 238.4d, 35% (107.28d) rise to max, Spectra M2e-M5e. Period analysis reveals that the star has exhibited only small variation between 235-242d. Observations since 2016 show a variation in both max and min of approximately one magnitude.



References

1. All data [AAVSO VSX]

2. Period plots and data are by Thomas Karlsson (SAAF) https://var.saaf.se/mirainfoper.php

The Spectroscopic Evolution of SN 2023ixf in M101 - The first 235 days

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A series of 22 low resolution spectra of supernova SN 2023ixf are presented covering days 3 to 235 post explosion. Spectra from three evolutionary phases are compared with past supernovae and key spectral features identified.

Introduction

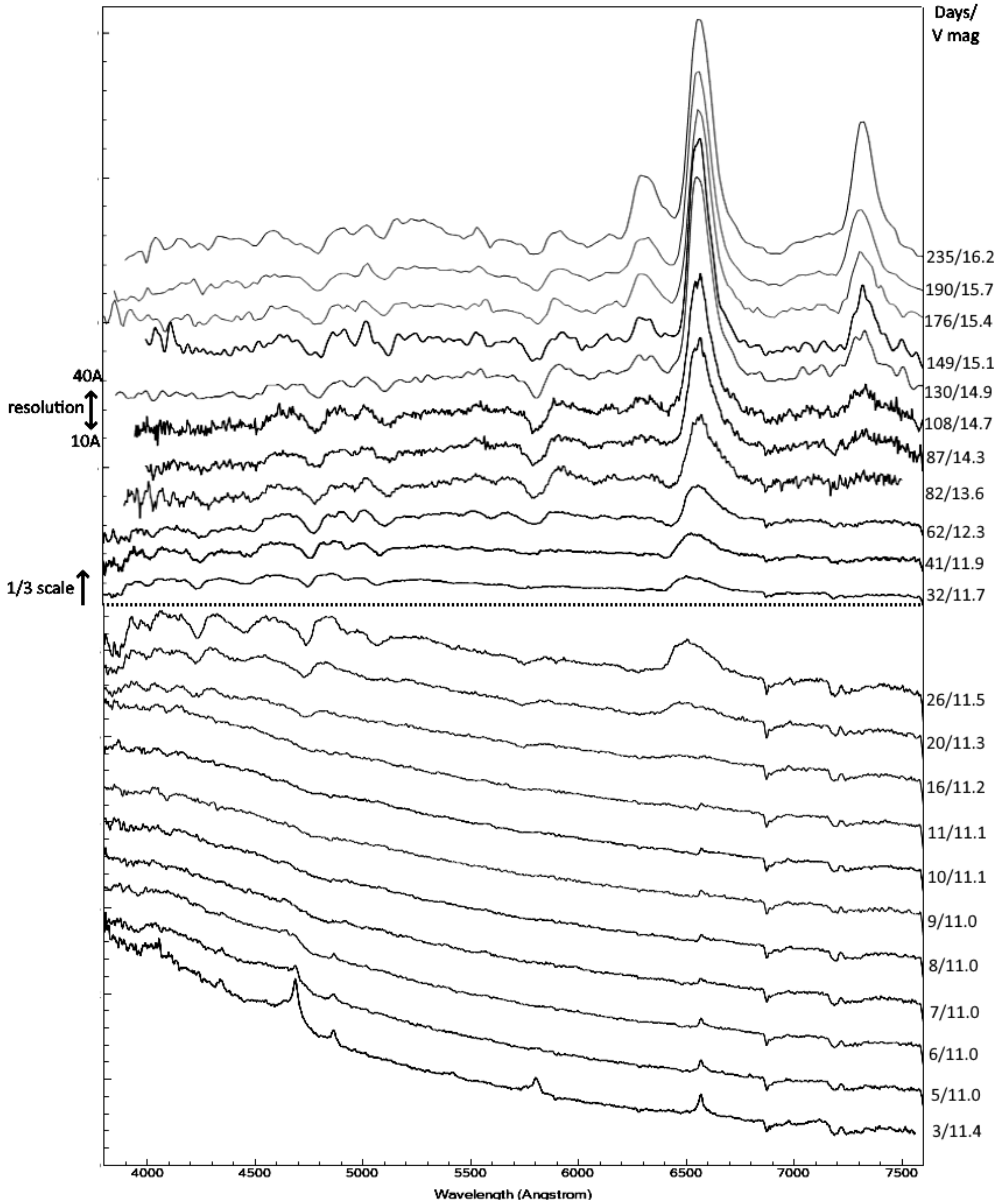
Supernova SN 2023ixf was discovered in M101 by Koichi Itagaki 20230519 UT 17:27, though pre-discovery images show it to have appeared approximately one day earlier. For the purposes in this study, I have adopted first light as 20230519 UT 00:01. It was initially classified as a narrow-lined Type IIn based on an early spectrum. This classification was subsequently revised to type II based on a later spectrum. [1]. A multi-band light curve by Ian Sharp covering the first 90 days has been published in the VSS Circular [2] and his measurements to date can be found in the BAA photometry database. [3]

Observations

The discovery coincided with a remarkable run of clear nights at Three Hills Observatory, allowing spectra to be recorded almost nightly, using a low resolution (R~550) ALPY600 spectrograph to cover the rapid evolution over the first 10 days from day 3 post explosion to when the supernova reached the maximum 11.0 V magnitude. Monitoring at a reducing cadence then continued to day 235 post explosion, changing to a lower resolution with a modified ALPY 200 spectrograph [4] (R~130) once the brightness dropped below magnitude 15.

Results

Figure 1 shows the evolution of the spectrum from day 3 to 235. This includes the initial flash ionisation, an often missed key phase which describes the interaction of the exploding material with the surrounding circumstellar medium. This is followed by the photospheric phase with strong broad P Cygni features and finally the nebular phase characterised by “forbidden” emission lines formed in the low density medium appearing in the spectrum. The spectra are calibrated in relative flux and scaled to 1 at 5500 Angstrom. Note the change in Y scale in the later spectra to accommodate the increasing relative intensity of the Hydrogen Balmer emission line.



Days/
V mag
235/16.2
190/15.7
176/15.4
149/15.1
130/14.9
108/14.7
87/14.3
82/13.6
62/12.3
41/11.9
32/11.7
26/11.5
20/11.3
16/11.2
11/11.1
10/11.1
9/11.0
8/11.0
7/11.0
6/11.0
5/11.0
3/11.4
40A
resolution
10A
1/3 scale
4000
4500
5000
5500
6000
6500
7000
7500
Wavelength (Angstrom)

Fig. 1

Figure 2 shows example spectra from each phase with key features identified from the literature [5]. Over-plotted in red are example comparison spectra of previous Type II supernovae at similar age, from the supernova identification program SNID [6].

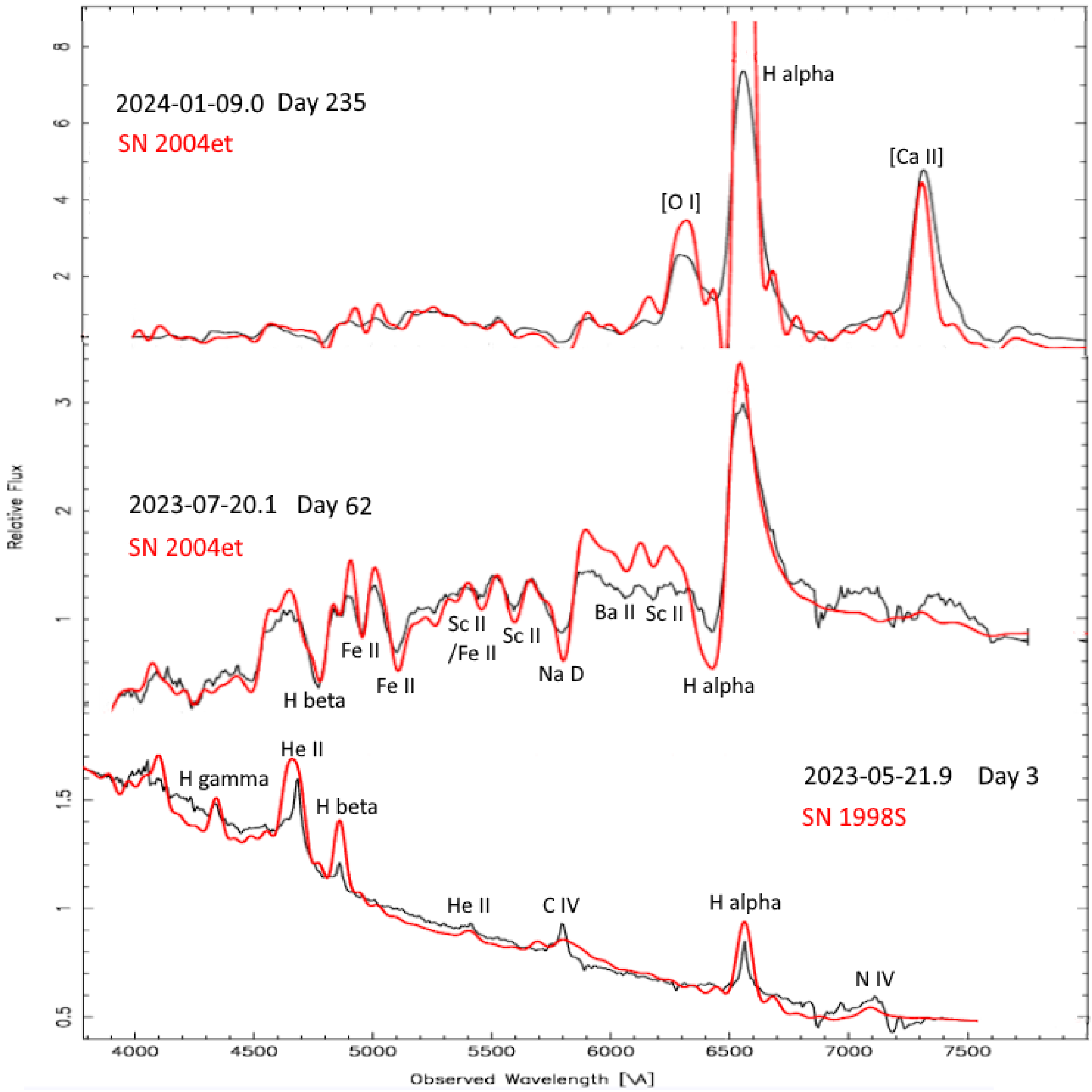


Fig. 2

It is planned to continue to follow the evolution of the spectrum of SN 2023ixf down to below magnitude 18 using the modified ALPY200, which has been in use at THO for the past ten years and which has recently become available from the manufacturer as an optional configuration for the ALPY600.

A series of animations based on these spectra can be viewed on the BAA website here.

https://britastro.org/observations/index.php?folder=20240213_141101_4aecb95f6a1e1006

and all the spectra are available for download from the BAA spectroscopy database.

https://britastro.org/specdb/

References

1. https://www.wis-tns.org/object/2023ixf IAU Transient Name Server

2. https://britastro.org/vss/VSSC197.pdf Supernova SN 2023ixf in M101. Ian Sharp. VSSC 197 page 21

3. https://britastro.org/photdb/ BAA photometry database

4. http://www.threehillsobservatory.co.uk/astro/spectroscopy_20.htm The ALPY 200 spectrograph

5. https://iopscience.iop.org/article/10.3847/1538-4357/aa8f52
Type II Supernova Spectral Diversity. I. Observations, Sample Characterization, and Spectral Line Evolution. Claudia P. Gutiérrez *et al* 2017 *ApJ* **850** 89

6. https://people.lam.fr/blondin.stephane/software/snid/ SNID supernova identification program

New Variable Stars in Messier 13

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Any observer equipped with a small telescope, CCD camera and photometric filters can study, confirm, or discover new variable stars in nearby globular clusters, such as Messier 13: in this article I explain how I achieved it.

Photometry of variable stars is a fun, entertaining and rewarding activity, especially when you discover a variable that has not been studied or recognised as such, and you communicate it to other astronomers so that they can observe and study it.

Last January I published a paper in the *Open European Journal on Variable Stars* (Violat-Bordonau, 2024) in which I studied two variable stars from the globular cluster Messier 13 called V10 and C6, the latter being a “candidate” for variable (hence *C*). There would be nothing special about this fact if it were not for the fact that C6, a mere suspect of variability, has already been recognized as variable and baptised with the pompous name of V65. This would not have been anything notable either, except that it is the third variable star that I discovered in the cluster after V63 (Violat-Bordonau, 2021), in March 2021, and V64 (Violat-Bordonau, 2022) in April of that year. How is this possible? What great telescope and wonderful CCD do I usually work? On which mountain in Hawaii or the Andes do I have the observatory installed? How many PhD students collaborate with me by extracting photometric measurements from the CCD images obtained?

I began to study star clusters in the 90s with the CCD cameras existing at the time, such as the SBIG ST-4 and similar: not having professional photometric filters, I worked with Kodak photographic filters (blue and green) and gained experience, obtained some interesting light curves, I published some simple results, I taught university students astronomical techniques and little else, all at the level of a humble but serious and conscientious semi-professional.

My interest in professional photometry began in the spring of 2000 when, using a paper on the variable stars of Messier 13 (Osborn, 2000), I created my own chart of the cluster. There was none that identified the variables, suspected of variability and the comparison stars: if you had access to SIMBAD or professional journals perhaps, with a lot of work, you could read the different studies published by Arp, Johnson and others in the 50s, 60s and later.

I use a catadioptric with a diameter of 203 mm and a focal length of 2000 mm: the aperture used does not matter (you can study the variables with a refractor of 75 to 90 mm in diameter!) but it is important, very important, that its focal length is greater than 1500-1750 mm to be able to separate the stars and measure them individually: this is what is known in professional literature as “stellar crowding”.

Using this telescope, a 16-bit Starlight Xpress camera, and a professional *V* photometric filter (Johnson system), I began to photograph the cluster: the campaign began in mid or late April, when the Spanish meteorology is favorable, and ended at the end of October or first days of November. It is very important to work every clear night; there is no point in obtaining 200 photometric measurements in a weekend or 50 over six months: the light curves obtained will be very poor and poorly sampled. In the 2021 campaign I worked 150 nights and captured 1,260 images: my red giant light curves are so detailed that Osborn himself used them in his monumental study of Messier 13 variables (Osborn, 2017). No one in the world (I say this without boasting it is true!) has curves of these variables with this wealth of points and quality: no professional has equipment that he can use, at his entire disposal or at his whim, for six or seven months in a campaign, every year... I forgot to mention that the 2024 campaign, which will begin in April, will be the twenty-fourth I have conducted: I have been studying the cluster for the last 24 years without interruptions.

My technique is simple but very delicate: every night I set the computer clock to the time by connecting via the Internet with some atomic clock: in the case of Spain with the official time server, the “Real Observatorio de la Armada;” in Great Britain could be Greenwich. In light curves of the slow variables (red giants) an error of a few minutes is not important: in the Cepheids and RR Lyrae it is, of course, since their periods are short (one to five days) or very short.

With the clock on time we prepare the twilight flats, the folder that will store the images of the night and we conduct other organisational tasks, we cool the camera, air the dome, etc. As soon as night falls, the dome is already open, balanced and I begin to take images with integration times of 120 to 180 seconds, depending on the limit magnitude that I want to reach: with 60 seconds I capture the red variables (mag. 11.8 to 13.5 *V*), with 120 seconds the Cepheids and RR Lyrae (mag. 13.5-14.8 *V*) and with 180-240 seconds the SX Phe variables (mag 16-17 *V*).

I always use professional photometric filters (Johnson or Cousin’s system) since, in addition to studying them, I want to publish the results in professional media: without filters they are useful, yes, but you cannot compare them with what other observers around the world will obtain. For the usual daily photometry, I use only the *V* Johnson but when I want to obtain a color-magnitude diagram of some area of the cluster, a survey, of it or even *B* and *V* light curves I use both. Occasionally I may conduct a study with the R_C (red) and I_C (infrared) filters, but they are few.

Every night I start the session with the cluster high in the sky: I try to start all sessions with the cluster at the same height to minimise the effect of the atmosphere. My sessions usually last 30 to 90 minutes, and in them I take 10 to 30 images: I could capture more but for a red giant it does not make sense, since in Messier 13 its periods range between 27 and 92 days. For fast variables it is interesting: that's why in periods of good weather I spend a week or ten days in a row, night after night, to obtain a dense set of data.

The filtered images treated for darks, flats and bias as soon as I acquire them (a good habit!), I store in folders, one per night, well identified and always with backup copies on two or more reliable media. Later I open these images with a program called FOTODIF (acronym for *FOTOmetria DIFerencial*, differential photometry), written by a Spanish amateur named Julio Castellano, which allows you to automatically measure all the images in an easy and automatic way: it doesn't matter if there are five or fifty... simply open the image, calibrate it indicating to the software which star(s) are the comparison stars, in which band (*B*, *V*, etc.) and their magnitudes. Now you indicate the stars you want to measure (variable, suspected of variability, check stars or all the ones that -on a whim- you want to measure...) and the software obtains the magnitude, the error, the signal-to-noise ratio, FWHM, the air mass and any other value that you need: in my case I only use the first ones. (I could use AIP4WIN or ASTROART but I find this one comfortable, easy, and very precise.) An example:

COMPARISON STARS

C1: 12.490 *V*

C2: 12.602 *V*

C3: 12.675 *V*

HJD (UTC)	VAR-11 MAG	+/-	SNR	FWHM
2460128.58720	11.982	0.006	181	3.21”
2460128.58869	11.985	0.006	187	3.05
2460128.59021	11.981	0.006	191	3.12
2460128.59179	11.988	0.006	188	3.20
2460128.59331	11.980	0.006	192	3.21
2460128.59481	11.983	0.006	188	3.11
2460128.59634	11.986	0.006	189	3.20
2460128.59786	11.986	0.006	187	3.22
2460128.59937	11.984	0.006	186	3.05
2460128.60092	11.980	0.006	186	3.29
2460128.60243	11.985	0.006	185	3.26
2460128.60396	11.979	0.006	189	3.04
2460128.60549	11.981	0.006	185	3.21
2460128.60707	11.980	0.006	185	3.19

I store the data obtained in a text file, one per variable, with its name: V2, V6, V8, V11... etc. In the 2023 campaign I have studied sixty different stars between variables, suspects, check stars, stars “on a whim” (looking for new variables, of course!), etc. I have obtained 1,300 frames and studied 60 stars: the total photometric measurements amount to 78,000! What professional astronomer has so much free time to measure or study them, one by one?

I open each of these files, which are just columns of numbers, one by one with a program called *Análisis de Variabilidad Estelar* (AVE), written by the “Astronomical Studies Group GEA,” but they could be opened and analysed with any other good program. Once opened, they show the raw light curve drawn by the variable over the weeks and months during which I have observed it: red giants show their semi-regular oscillations while the fast variables (Cepheids and RR Lyrae) they only offer boring gibberish; it is necessary to draw them in phase with their period, either the official one (it may have changed!) or with the one that I determine using an algorithm, in my case the most useful is Scargle's (Scargle, 1982) valid both for very well sampled measurements over time as if they have been obtained with long time intervals and large data gaps.

From my images I obtain light curves, *V* band amplitudes and periods of the variables, something easy even with a small refractor for all those stars located on the periphery of the cluster (remember the *crowding*). With long focal lengths (2000-3500 mm or even more) we can even study the variables located in the heart, the core, of the cluster.

Why do I study Messier 13 if it has been photographed since 1898 and is well studied? Well, in each image there appear 500 to 2,000 stars or even more, if the exposure time is longer than 240-300 seconds: have they all been measured photometrically over 150 nights for several years in a long campaign? Of course not! The field covered by my chip is around 15 minutes of arc: the one studied by professional telescopes (including university ones) focuses on the first 5-8 arcminutes, and the peripheral stars have not been studied! In fact, in 2019 Deras discovered a new RR Lyrae (V54) far from the nucleus.

Taking images every clear night, I have been able to discover two bright and, theoretically, very easy variables: V63, of magnitude 12.19 *V* located at the end of a “spider leg” in the southern zone of the cluster, and V64, which although close to the nucleus (and the Cepheid V2) no one has noticed its tiny oscillations. I'll be honest: a couple of astronomers detected them in 2000 -Osborn- and 2003 -Kopacki *et al.*- but didn't have the courage to take the risk and publish... the measurements of Kopacki, which he sent me, demonstrated their variability and I used them in one of my photometric works. I confirmed the third variable, V65, last January by measuring one of the 15 candidate variables announced by Deras in 2019: the remaining fourteen are unconfirmed. Until today.

I encourage everyone interested in photometry to observe the cluster for a week or two, or even longer if you wish: M13 is high in the sky in spring and summer, many of you have good equipment, cameras, filters and experience to obtain good light curves of the variables and the suspected variable stars; you can also confirm a dozen stars that have not been well studied or discover many others among the brightest stars.

My chart identifies the red giant variables (labeled in red), the Cepheids (labeled in green, there are only three: V1, V2 and V6) and some RR Lyrae (blue: V7, V8 and V31 among others) as well as six stars of comparison labeled with the letter **L** (Ludendorff, 1905). Candidate variables are named with the letter **C**: C1, C2, C4, etc. written in red or blue (like C12, a *blue straggler* star) according to their own color. The *V* magnitudes and *B – V* colors of the comparison stars, taken from the paper of Stetson *et al.* (2019) are the following:

Comparison and check stars

Star	ID	RA (J2000) [h:m:s]	DEC (J2000) [° ' "]	*V* [mag]	*B – V* [mag]
L745	2MASS J16414486+3630514	16:41:44.85	+36:30:51.37	12.490	1.293
L244	2MASS J16413437+3625048	16:41:34.36	+36:25:04.76	12.602	1.225
L158	2MASS J16413053+3629434	16:41:30.52	+36:29:43.44	12.675	1.144
L353	2MASS J16413725+3629368	16:41:37.24	+36:29:36.77	12.809	1.138
L1073	2MASS J16420085+3623338	16:42:00.84	+36:23:33.67	12.859	1.087
L848	2MASS J16414739+3625111	16:41:47.40	+36:25:11.13	13.110	1.071

You can consult the updated data of all the variables of M13 (position, magnitude *V*, amplitude, period, etc.) in the *Catalog of Variable Stars in Globular Clusters* (University of Toronto, Canada) at this link:

https://www.astro.utoronto.ca/~cclement/cat/C1639p365

If you have any questions, queries, need photometric measurements, collaboration, or a best chart from the cluster (there are more variables, I haven't been able to mark them all so as not to saturate the chart), you can request them to me by email. Thanks, and good luck to everyone!

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AVE, Análisis de Variabilidad Estelar, G.E.A: *AVE Análisis de Variabilidad*

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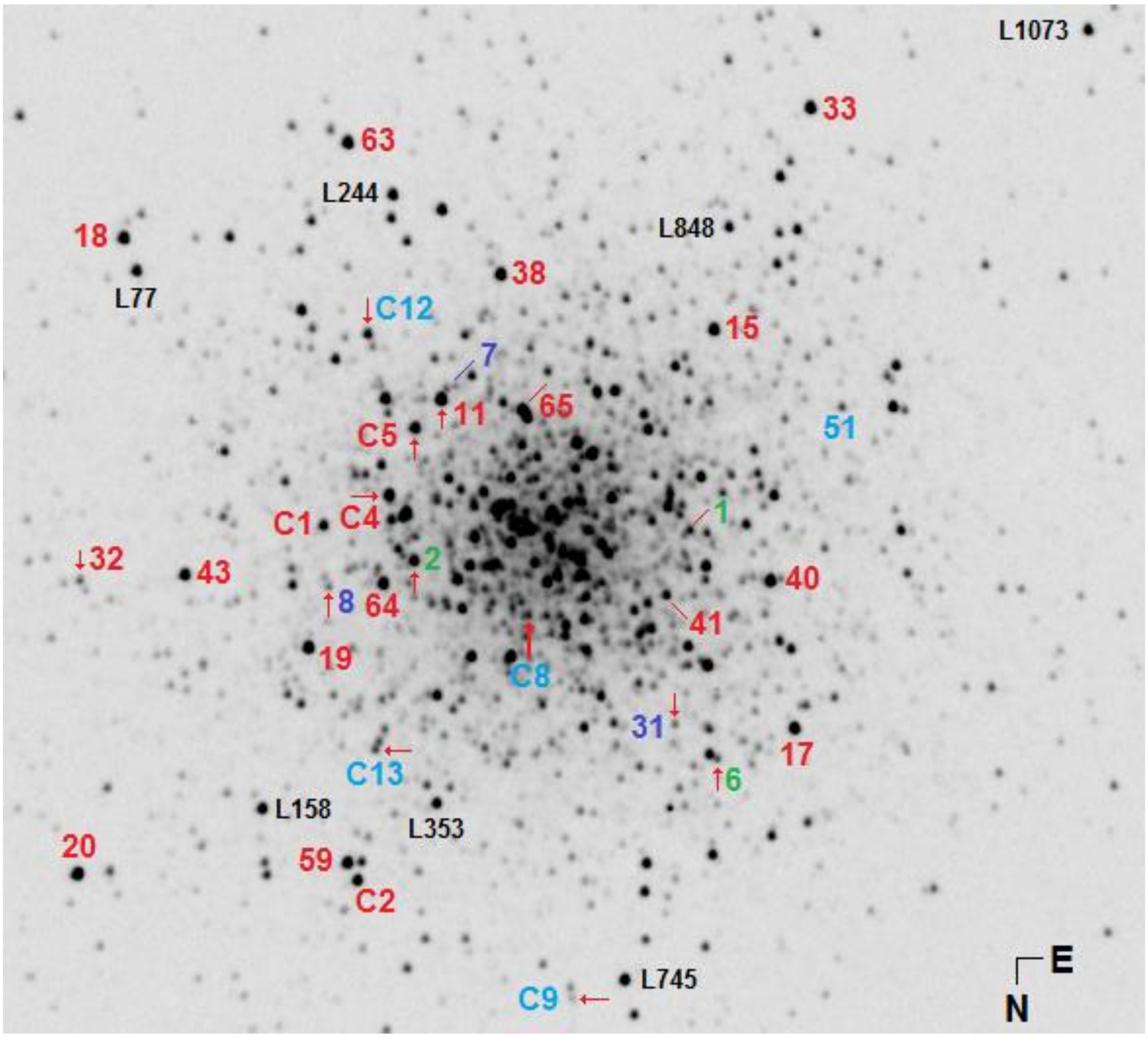
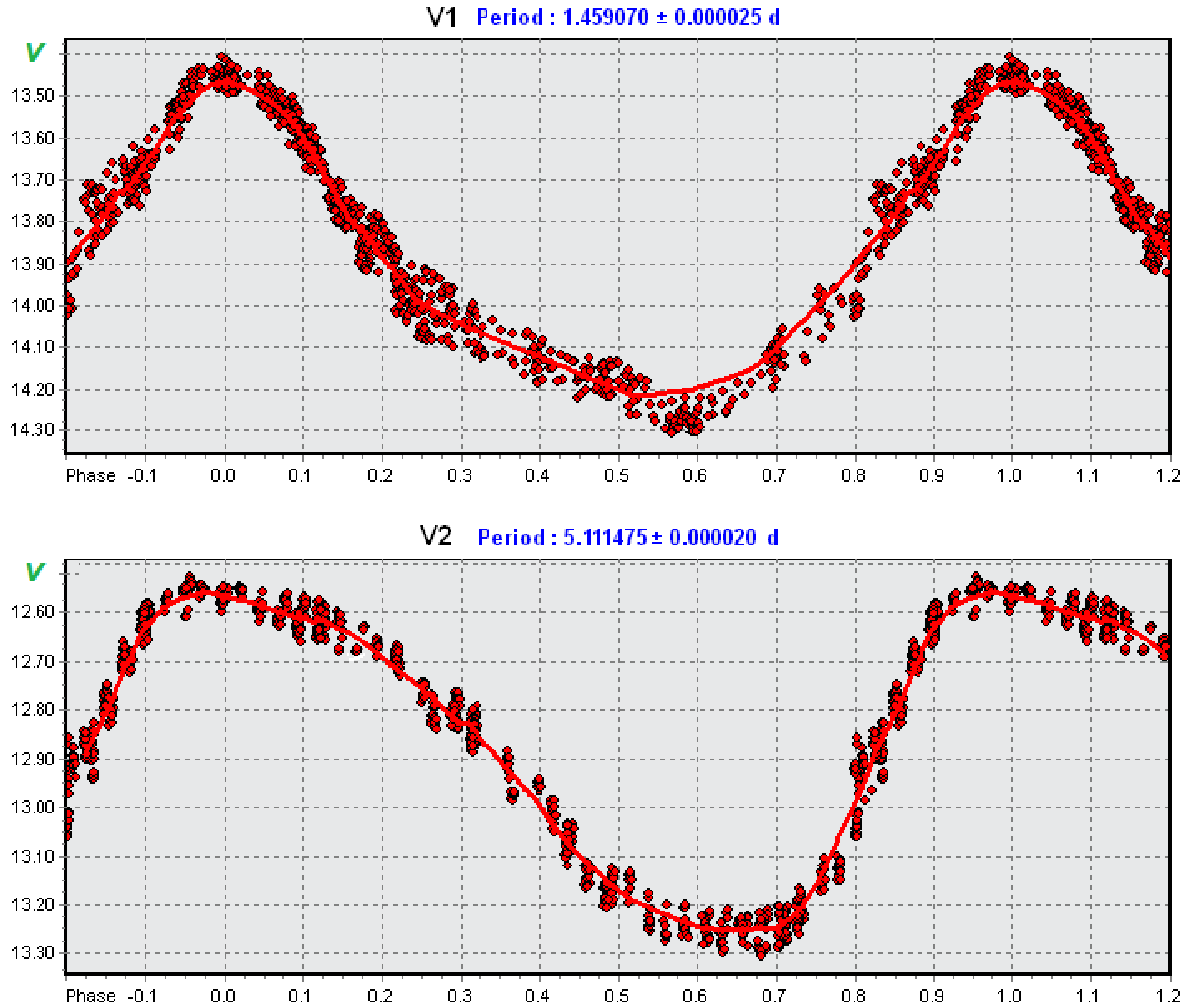
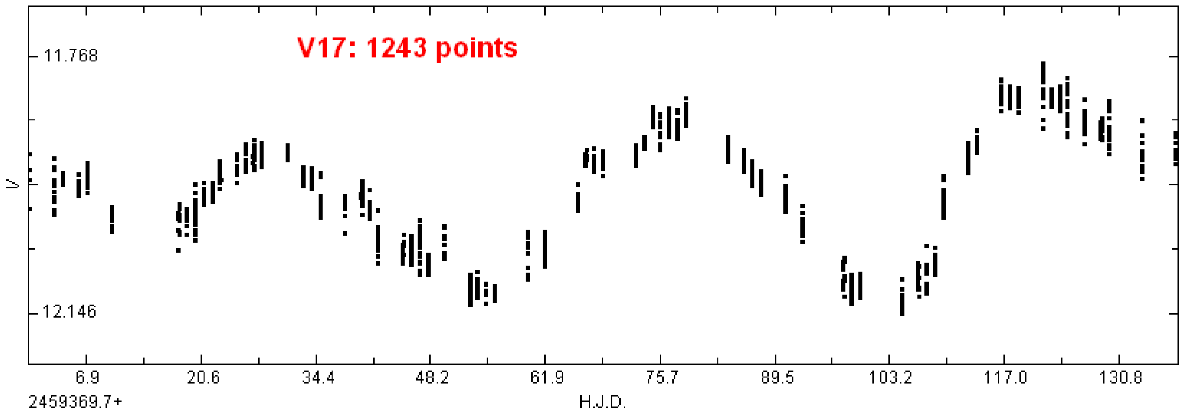
Stetson, P. B. *et al*., 2019, MNRAS, 485, 3042: [2019MNRAS.485.3042S]
Violat-Bordonau, F., 2021, OEJV, 213, 1: [2021OEJV..213....1V]
Violat-Bordonau, F., 2022, OEJV, 222, 1: [2022OEJV..222....1V]
Violat-Bordonau, F., 2024, OEJV, 244, 1: [2024OEJV..244....1V]

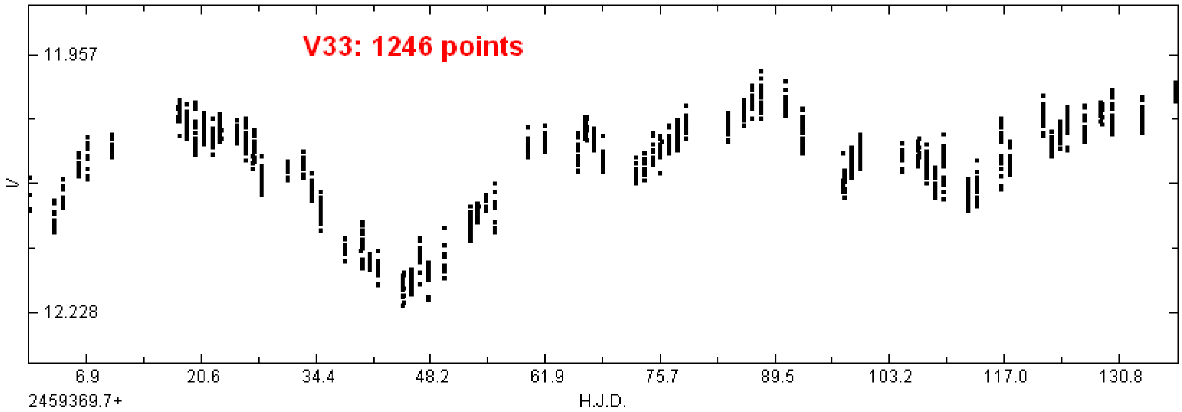


Messier 13 chart: the photometric calibration and check stars are labelled with the letter "L" followed by a number; also, the variables (with their numbers) and candidate variables labelled with the letter "C", in red (red giants) or blue (Cepheids or RR Lyrae) according to the colour of the stars or candidates.



Light curves of the Cepheid variables V1 and V2, in *V* band, obtained with my team in the 2021 campaign.





I present the light curves, in Johnson *V* band, of the red giant stars V17 and V33 obtained in the 2021 campaign over almost 150 nights: their official periods are 43 and 33 days respectively. In the case of V33, micro changes of a few hundredths of magnitude are seen in just over a week.

Eclipsing Binary News

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V480 Lyr

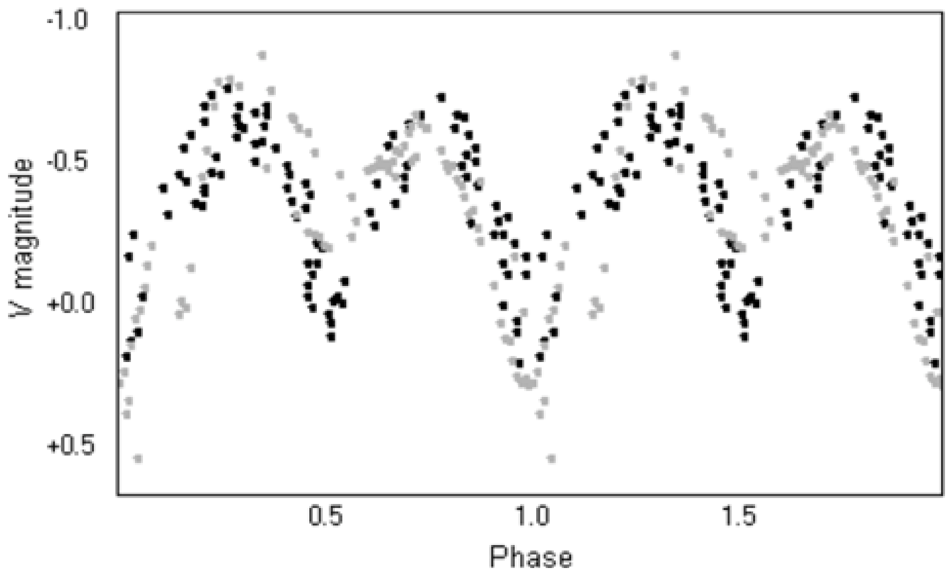
GCVS catalogues V480 Lyr as an eclipsing binary which varies between 13 and 15.3 magnitudes, but it does not state a period nor the class of eclipsing binary. Wikipedia refers to the variable in its entry on 'beta Lyrae variables.'

"The light curves of beta Lyrae variables are quite smooth: eclipses start and end so gradually that the exact moments are impossible to define. This occurs because the flow of mass between the components is so large that it envelopes the whole system in a common atmosphere. The amplitude of the brightness variations is in most cases less than one magnitude; the largest amplitude known is 2.3 magnitudes (V480 Lyrae)."

Wikipedia therefore considers that V480 Lyr is an eclipsing binary of the beta Lyrae class.

The Krakow database does not list the eclipsing binary at all. This may be because of a 2009 paper which was published in the JAAVSO (1). The paper says that the initial classification was based on work published in 1983. This work stated that the period was 100 days though this seems to be inconsistent with its classification as a beta Lyrae variable. The stars in the system would not be able to share a common atmosphere as they are too far apart. Wikipedia lists some eclipsing binaries of the Beta Lyrae class including ups Sgr which apparently has a period of 137 days. This system is not now considered an eclipsing binary (2).

V480 Lyr was later interpreted as a Cepheid with a period of 45 days, The 2009 paper considers that this system/star should be classified as an RV Tauri variable. These variables (according to Wikipedia) have alternating deep and shallow minima which could have a superficial resemblance to



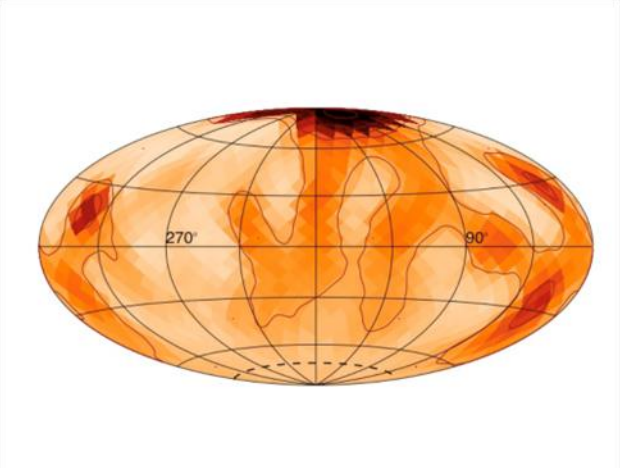
Back to contents

beta Lyrae eclipsing binaries but can be distinguished by the distinctive nature of the light variations. Their variations in luminosity are not due to eclipses but to radial pulsations of their surfaces. They are a type of Cepheid. Above is a light curve of V480 Lyr published in the 2009 paper (1).

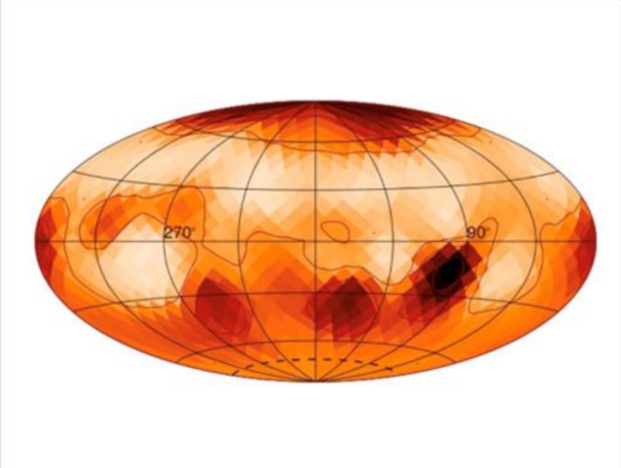
It is worth bearing in mind, as Wikipedia states, that RV Tauri variables can be in binaries with a dusty disk and, therefore, could also be in an eclipsing binary system with two different types of light curves superimposed.

zeta Andromedae

Zeta And is an eclipsing binary system of the Beta Lyrae class which is about 189 light years away. This is near enough for the primary star to be directly imaged by CHARA (The Centre for High Angular Resolution Astronomy). Below are images from the CHARA website: < https://www.chara.gsu.edu/press-release/zeta-andromedae>. The movement of large star spots can be seen.



July 2011 Surface image of ζ And.



September 2013 Surface image of ζ And.

Zeta And is a bright EB which varies between 3.92m and 4.14m with a period of about 17.77 days. It is sub classified as an ELL/RS system.

The system is a target for DSLR photometry. Zeta And at 4.37m may be a possible comparison. One measurement per night would be sufficient to construct a light curve but more measurements might pick up changes due to the rotational movement of the star spots.

W UMa class systems

A recent Nature paper (3) presented a catalogue of approximately 1800 Eclipsing W UMa systems. The study found that the vast majority of the systems are Late type stars primarily classified as F spectral type, followed by G and K. They also found 88 systems of A spectral type. It is suggested that these systems may have a different evolutionary history and may require further investigation. They may end up in a class of their own.

Types of Eclipsing Binary Systems

There are a number of YouTube presentations that may be useful educationally at schools and local societies. One of these is by ‘Professor Dave’ (https://www.youtube.com/watch?v=AnE9EYgXxpU)

References

1. ’Deciphering Multiple Observations of V480 Lyrae’, J.D. Horne, JAAVSO Volume 37, pp 128-136, 2009.

2. ‘The circumbinary dusty disk around the hydrogen deficient star Ups Sgr’ M. Netolicky et al, A&A Vol 499, 3, 2009, pp 822-833.

3. Physical characterization of late-type contact binary systems observed by LAMOST: a comprehensive statistical analysis.’ Abdel Rahman, H.I., Darwish, M. *Sci Rep* 13, 21648 (2023). https://doi.org/10.1038/s41598-023-48507-5

Observations of the eclipsing binary TT Aurigae, including a primary and a secondary minimum, together with a determination of the mean period over the past seven years.

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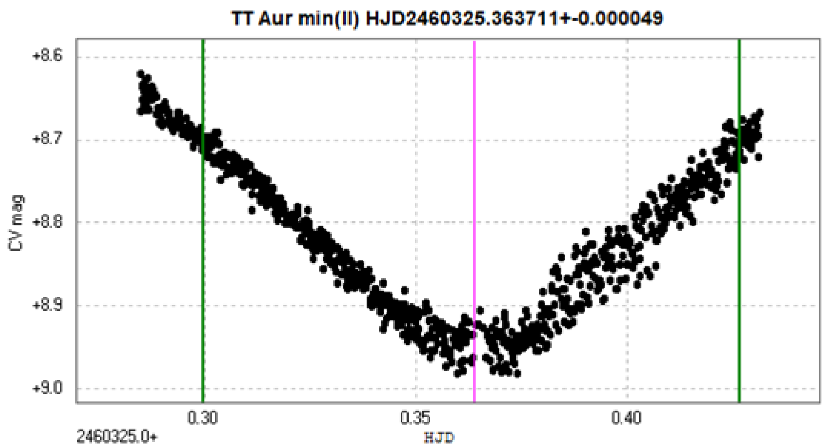
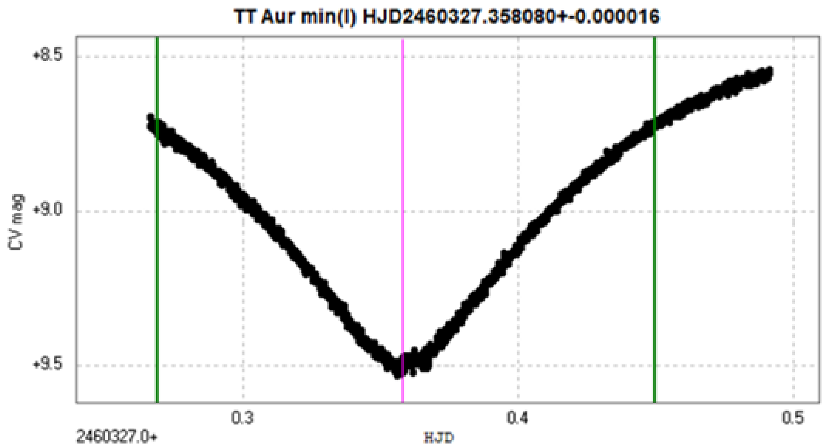
Recent observations of the eclipsing binary TT Aurigae, obtaining timings of a primary and a secondary minimum

TT Aurigae is listed as an EA type eclipsing binary in the GCVS and as an EB/DM type in the AAVSO VSX (accessed 2024 February 12).

Taking advantage of a number of clear nights in January, I observed TT Aurigae for just over 14 hours over three sessions with the 2 inch Titan at Somerby Observatory. The images were not filtered.

A secondary minimum was observed on January 15 and a primary minimum was observed on January 17, and are shown below.

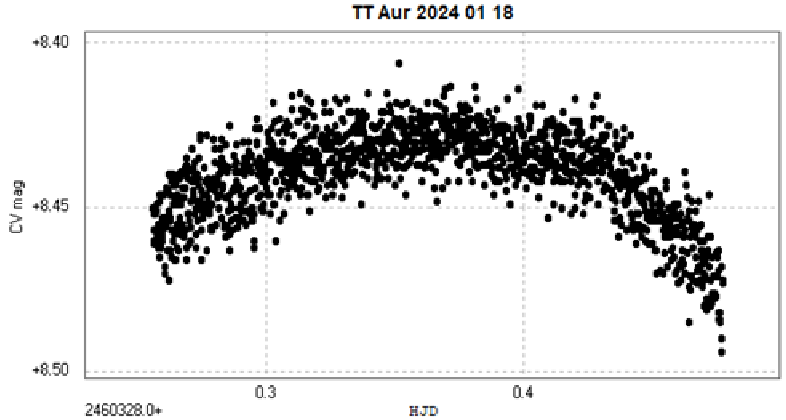


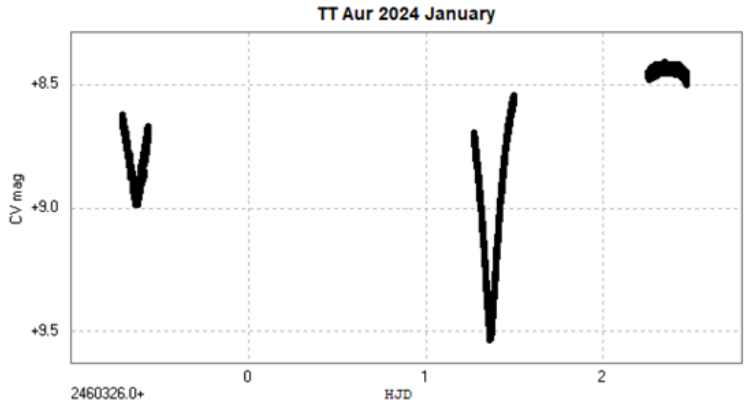


The HJD of these minima are given in the following table.

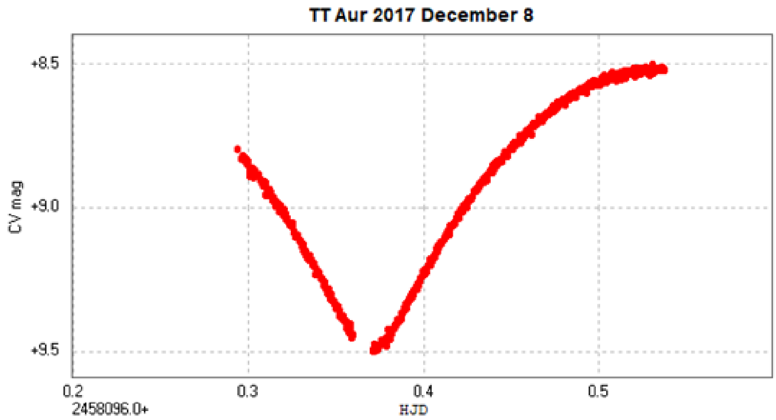
Star	HJD of min	Filter	Error	Type of minimum
TT Aur	2460325.363711	CV	0.000049	secondary
TT Aur	2460327.358080	CV	0.000016	primary

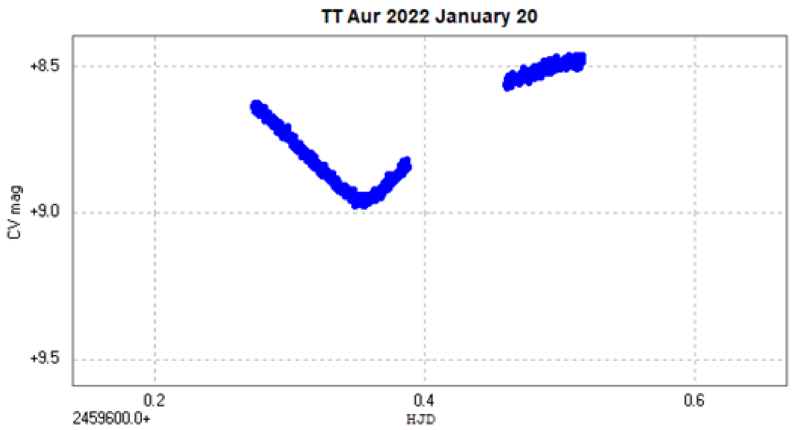
A maximum, between a secondary and a primary minimum, was then observed on January 18 and is shown below (first figure), (note the differing magnitude scales). This is included in the complete light curve for all three sessions in the second figure.



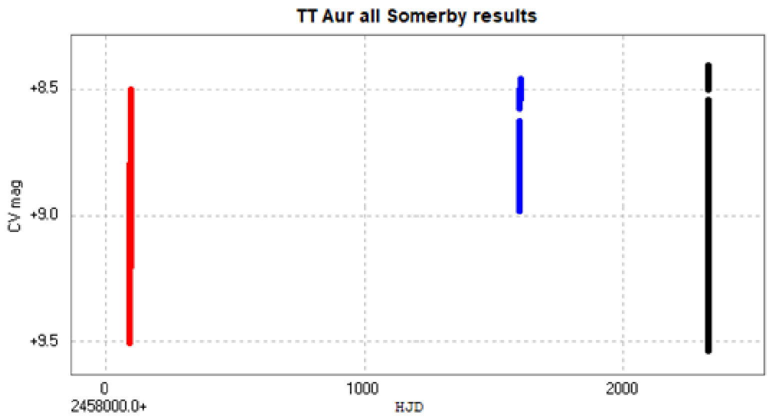


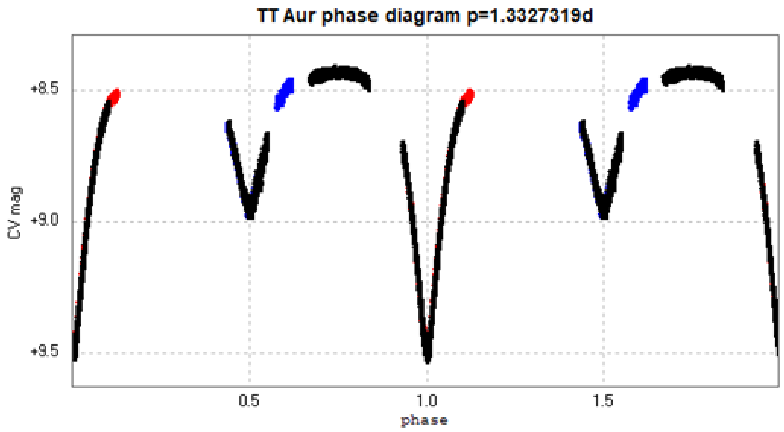
I had previously observed a primary minimum on 2017 December 8, and a secondary minimum on 2022 January 20, also with the 2 inch Titan, as follows.





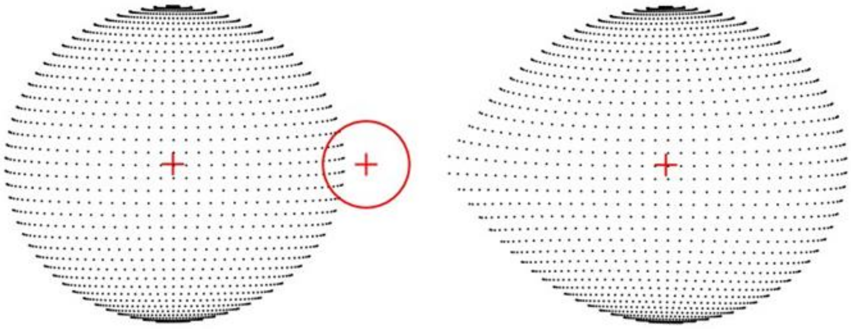
The combined light curve and phase diagram for all three sets of results (2017, 2022 and 2024) follow.





The period of the phase diagram, 1.3327319d, is the 'best fit' period for this time interval suggested by Peranso/ANOVA. This compares with the 1.332735 day period in the GCVS and the AAVSO VSX (accessed 2024 February 12).

Below is a Binary Maker 3 model of the system, based on work by Bell *et al* (1986), where the red circle centred on the barycentre illustrates the size of the Sun.



The following articles discuss some research about this system.

TT Aurigae: a B-type semi-detached eclipsing binary, Popper *et al* (1986)

Gravity Darkening in Semi-Detached Binary System TT Aurigae, Djurašević and Erkapić (2000)

UBV Photometry of the Massive Eclipsing Binary TT Aur, S. Özdemir *et al* (2001)

More information can be found on my website.

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Back to contents