Newsletter 2022-2

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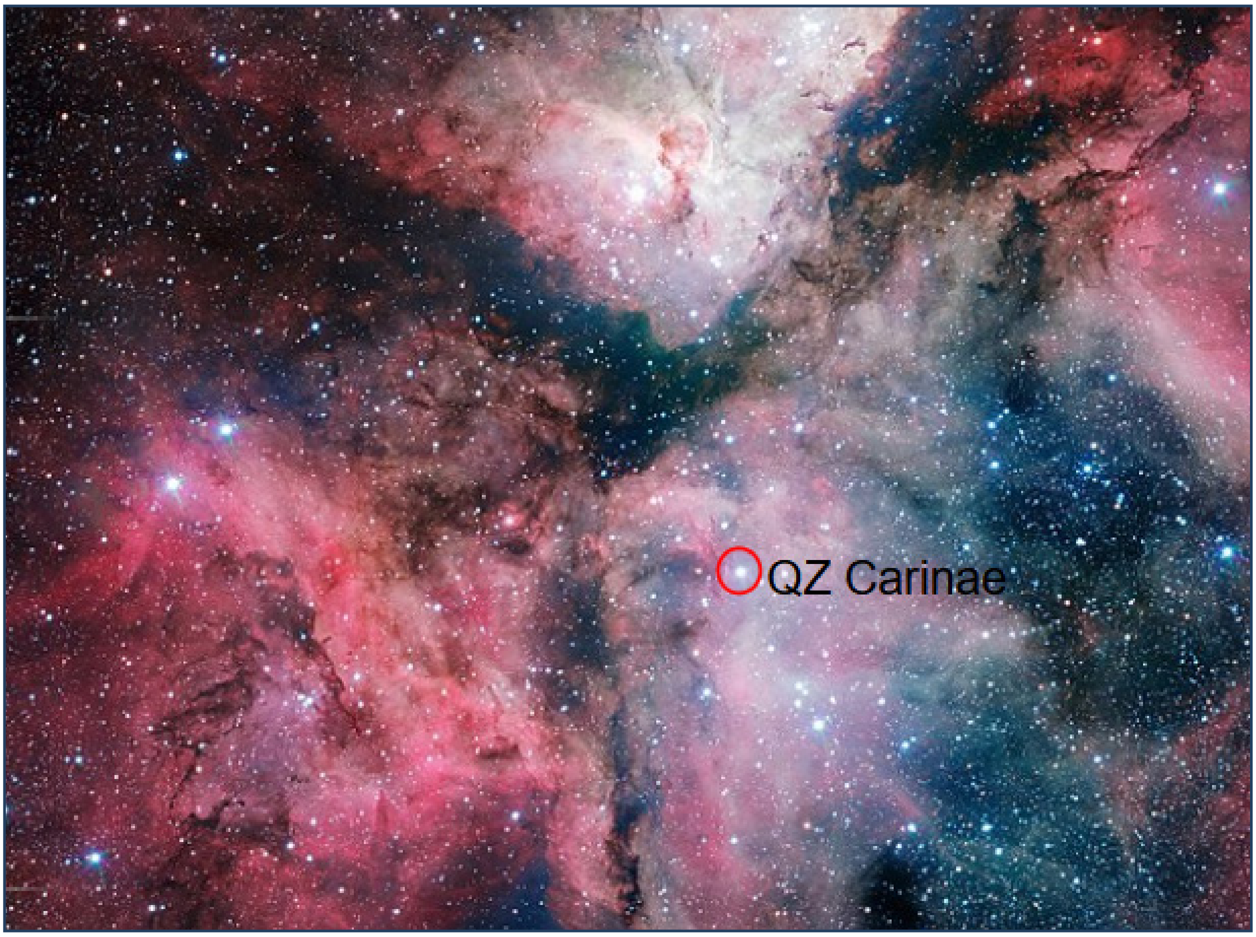

QZ Carinae is a quadruple star system in the heart of the beautiful Carina nebula consisting of an eclipsing pair and a non-eclipsing pair of stars. The exact periods of this system are still in some doubt but Stan Walker sheds some light on the puzzle in his article on page 18. https://www.eso.org/public/images/eso0905a/

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From the Director - *Mark Blackford*

Welcome to the second edition of the Newsletter for 2022. I'd like to thank all the contributing authors for sharing their projects with the community.

The RASNZ Conference and AGM will be hosted by the Northland Astronomical Society over the weekend of Friday 3rd to Sunday 5th June 2022. The venue will be the Barge Community Events Centre, Whangārei. It would be great if someone attending the meeting could report on any variable star related presentations in the next newsletter.

For those interested in the details of how photometry software calculates star magnitudes from digital images I recommend a recent video tutorial "How to Understand Star Photometry: How it Works" by Richard Berry. He demonstrates using his AIP4Win software, but all stellar photometry software works pretty much the same way. This video complements an earlier video "How to start with CCD photometry" in which Bob Buchheim introduces the concept of stellar photometry, some differences in imaging techniques when your goal is "measurement" vs. "beauty," and offers suggestions for your first few variable star activities. Both videos are part of the AAVSO's How-to Hour series.

Summer and early autumn have continued to be dismal for astronomy at Congarinni observatory. Since mid-November I have been unable to conduct any photometry. I installed a new electronics board in my Paramount MX+ mount and communication with the laptop computer is working again. However I have not been able to test the mount properly due to persistent cloudy weather. I hope you have fared better.

Wishing you all clear skies and good health.

RASNZ annual conference

Conference Registration

The AGM and Conference will be held In Whangarei this year, 3rd June - 5th June. Please see the RASNZ Conference website: https://rasnzconference.org.nz/ for registration details and details of any Covid restrictions.

Guest speakers

Dr John C Mather --Senior Astrophysicist in the Observational Cosmology Laboratory, NASA's Goddard Space Flight Center and Senior Project Scientist on the James Webb Space Telescope.

Dr Emily Kendall is a post-doctoral researcher at Auckland University and part of the New Zealand contribution to the LISA project.

Glen Rowe was made a Fellow of the Royal Astronomical Society of New Zealand in 2020 and will give his Fellows lecture at the opening of the conference in Whangarei.

R CMa: The puzzling Algol – *Ed Budding*

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Abstract

The unusual Algol type eclipsing binary system R Canis Majoris is reviewed. The role of angular momentum in the lead up to the presently observed configuration is noted, as is the possible application of astrometric techniques. A feasible connection with certain contact binaries is briefly discussed.

R CMa and Algols

The variable star R Canis Majoris is a relatively bright (B ≈ 6.05; V ≈ 5.71) eclipsing binary with a fairly short period (P ≈ 1.136 d). A few degrees east of Sirius in the sky, it is located about 44 pc distant from Earth. Its F0 type primary star appears similar to a typical Main Sequence dwarf, but the low-mass cool G8 type subgiant points to a 'classical' Algol configuration.

This arrangement for a binary star was jokingly characterized by Fred Hoyle as the 'dog-eat-dog' scenario, after the idea of interactive binary evolution gained currency in the mid-fifties. The main thing here is that the originally more massive star has a faster rate of evolution than its companion. It swells up and, at some point, starts to spill over to the other star. In due course, this becomes the new primary. The former primary keeps much of the core that it would have had if it could have stayed single, but its envelope is now a shadow of the giant it would have then become. Most of its erstwhile mass has been transferred to the former secondary, which, normally having the appearance of a typical Main Sequence star, conceals much of the evidence of the large scale of the interaction. At length, the original primary ebbs slowly away, the intense mass transfer of the early period of the process now reduced to a mere trickle.

This Algol-type classification has been supported by numerous studies since the discovery of the variability by E. F. Sawyer in 1887. An early review was that of F. B. Wood, who remarked on a "puzzling" nature in the case of R CMa, referring to oddities from Harlow Shapley's analysis of O. C. Wendell's light curve (LC). Edward Pickering had also produced an LC and noted the existence of occasional photometric irregularities. Of more local interest, such irregularities are present in the LCs of R CMa produced with the automated `robotic' C14 Compustar[1] at the Kotipu Place Observatory (NZ) in the mid-nineties.

Parametrizing the stars: Russell's royal road

A radial velocity (RV) curve for R CMa was published by F. C. Jordan from the Allegheny Observatory. It had been pointed out by Henry Norris Russell that combining the results of radial velocity measurements with those from the light curve would allow basic stellar parameters, like the masses, sizes and luminosities, to be determined in standard units. This would be particularly effective when both components' spectra could be clearly separated out. This combinatorial approach was styled the `royal road' to knowledge of the stars. It is still there, though naturally with appropriate developments due to modern methods and additional techniques.

Although Jordan's observing conditions were not good (100 min exposures) for this southern star (declination about –16 deg), and his RV curve looks to have a significant eccentricity, the main results (primary velocity amplitude = 28.6 km/sec, mean RV = –39.7 km/sec) are surprisingly close to recently adopted values (check out the SIMBAD data-base).

B. W. Sitterly, on the other hand, using later data from the respected observer Alfred Joy obtained with the 60" Mt. Wilson reflector, found significantly different RV amplitude and mean velocity values, while rejecting any orbital eccentricity, as did Willem Luyten who also studied R CMa. Brad Wood and other early observers took seriously the apparent sudden change of period that occurred around 1915. That has come to be regarded as a rapidly changing part (near the periastron) of some more long term (~93 y) cycle. The HIPPARCOS satellite's photometrically derived period of 1.13596 d is certainly longer than that used by Wood (1.13594 d).

1 This facility is currently "looking for a new home".

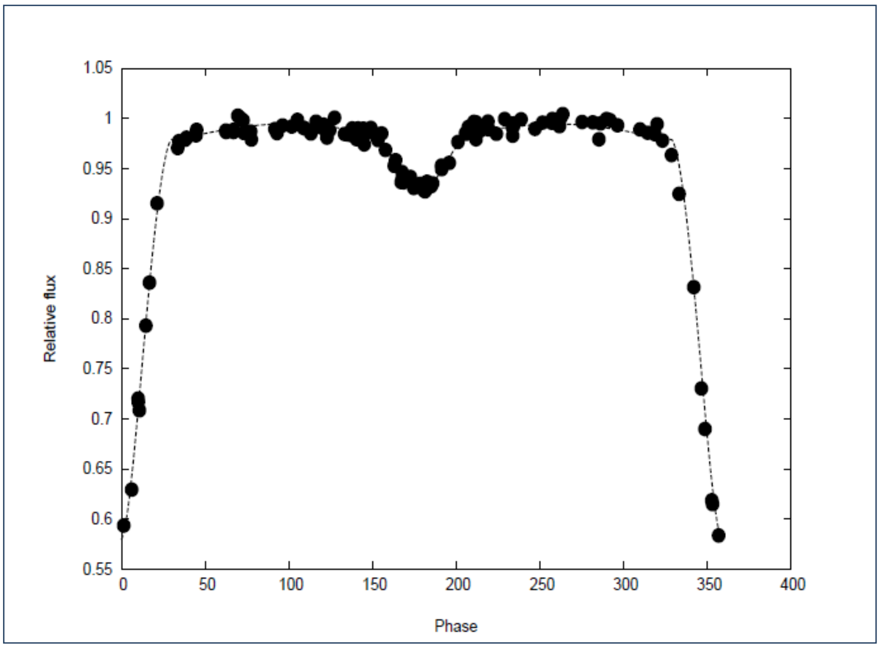

Figure 1. *HIPPARCOS light curve of R CMa. These data can be matched by the (near V-band) LC of a standard eclipsing binary model, though there is an appreciable scatter. The nearly flat out-of-eclipse portions of the LC testify to the low scale of tidal distortion of the relatively bright primary star. This, in turn, points to a low mass secondary.*

In 1985, Jocelyn Tomkin succeeded in measuring absorption lines from the secondary, however, the derived masses implied the primary to be significantly more luminous than the expected Main Sequence-like properties discerned for most Algols. This situation had been countenanced by Zdenek Kopal in his 1956 review of the main categories of close binary systems. At that time, Kopal proposed the existence of a group of binaries with over-luminous primaries in a similar configuration to R CMa. Later checking of the RVs with more modern and upgraded spectrographs has resulted in higher masses for most of these systems. Kopal's original identification of Algols of the 'R CMa type' as those with over-luminous primaries looks to have come mainly from erroneous absolute parameter values.

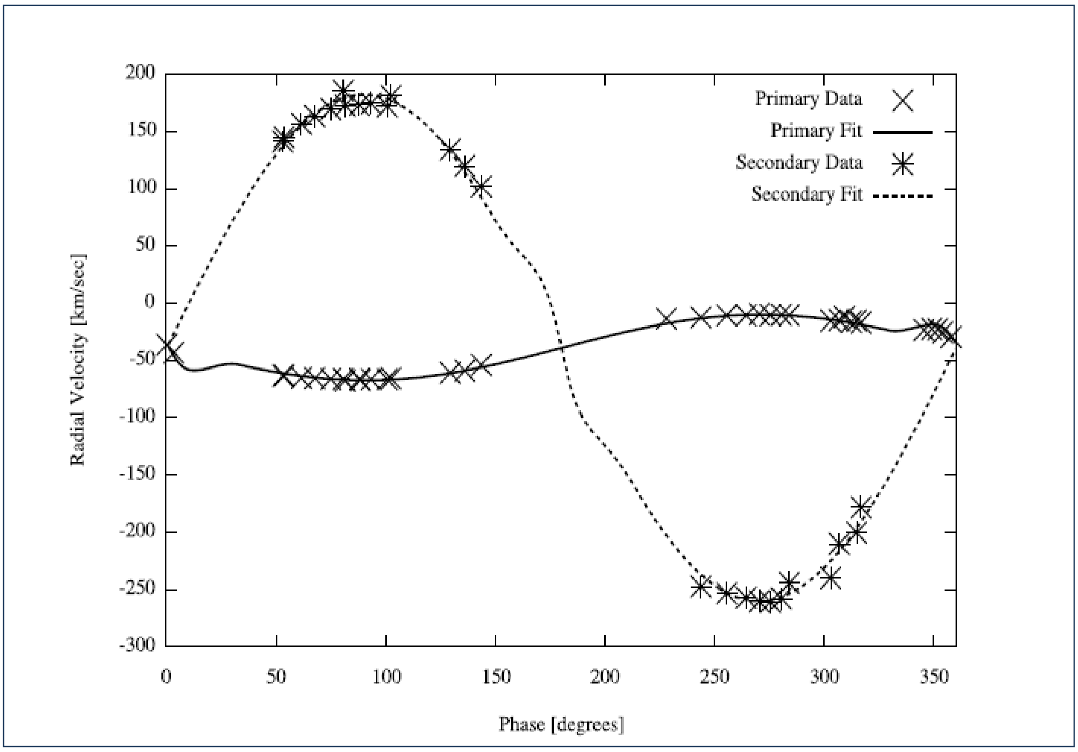

Figure 2. *Mt John's Hercules spectrographic RV curves, primary and secondary for R CMa.*

Even so, there remains that combination of the low mass ratio and period. The problem is seen if we 'evolve backwards' such binaries according to the generally accepted idea of interactive Algol evolution presented above. If R CMa's angular momentum was mostly conserved in this phase, the two stars must have been very close and deeply immersed in a common envelope around the time when their masses were approximately equal. On the face of that, there arises strong doubt as to how the system could avoid melding into one object and emerge as a still intact Algol.

The semi-detached configuration found by nearly all analysts is almost inevitably implied by the secondary's low mass, yet not so low effective temperature (~4250 K), since even the more recent secondary mass is still less than 1/4 that of the Sun. The ~60 % upwardly revised masses, on the basis of a very few observations (though high precision, and from the McDonald Observatory) by L. V. Glazunova et al, was a good motivator for more new RV data and analysis to get a firmer grip on basic information. The situation prompted Roger Butland and this author to pursue using the McLellan 1m telescope and Hercules spectrograph at Mt John Observatory to explore R CMa a bit further. The observations shown in Fig 2 date from around 2011. They supported the revised masses of Glazunova and essentially dispensed with the original R CMa mass/luminosity issue.

Astrometry of binary stars

Apart from the classical combination of photometric and spectroscopic approaches to binary star parametrization, in 2002, Ignasi Ribas, Frederic Arenou and Ed Guinan had the idea of introducing astrometric data into the mix. This is on the basis that the timing of LC minima (ToM) suggests the presence of a wide companion in a ~93 yr orbit. Such a third body could be involved in angular momentum exchange and may offer a means of explaining the outstanding low mass-ratio + low period problem. Figure 3 shows this ToM data, expressed as an "observed minus calculated" (O – C) diagram.

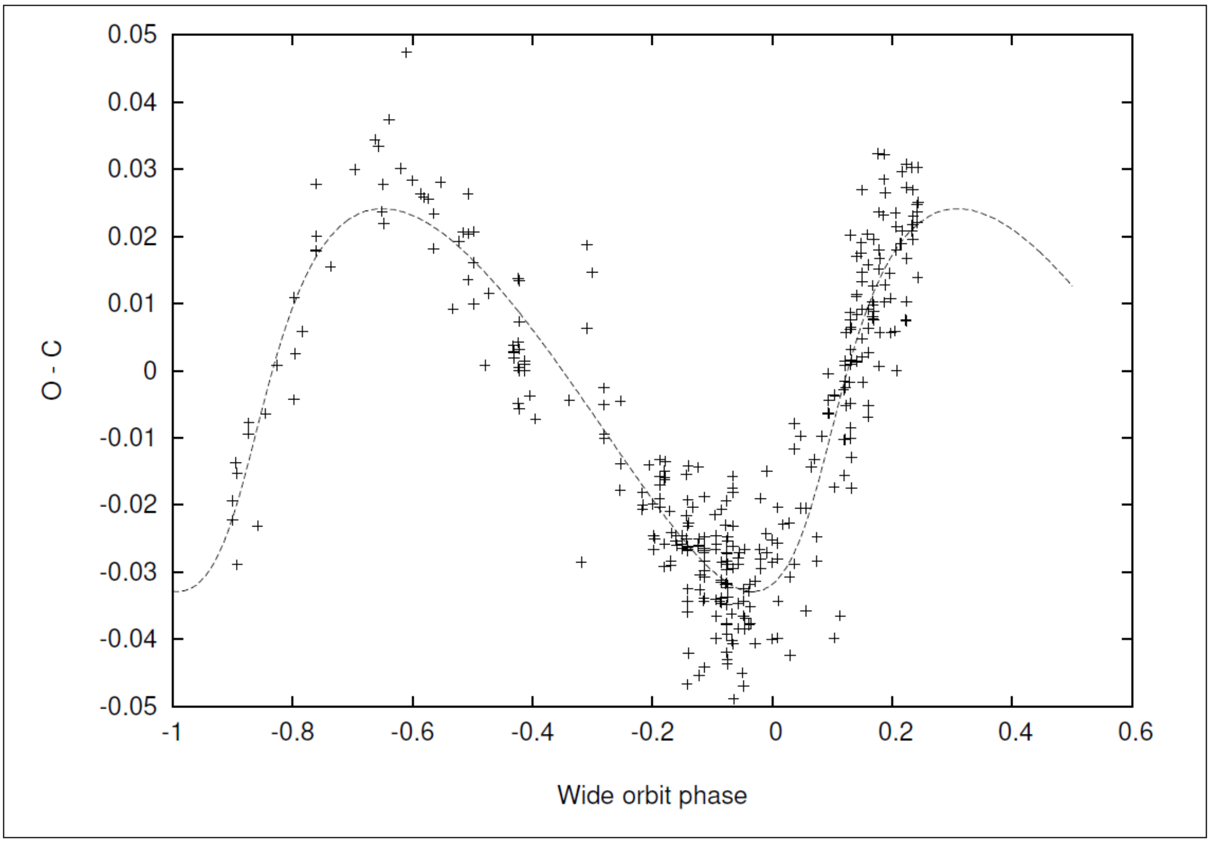

Figure 3. *The timing of eclipse minima for R CMa show a departure from regularity that can be suitably modelled as a `light travel time' (LTT) effect, due to the close-binary having a wide orbit relationship with a third star.*

O – C data are associated with the LC of the close binary, where calculated ToMs coming from an adopted ephemeris are compared with what is actually observed. When these show a light time effect (LTT), as in Figure 3, analysis suggests the possibility of modelling wider configurations using astrometric data.

The data and the reference ephemeris used in constructing Figure 3 came, originally, from J. Kreiner et al.'s Atlas of O – C diagrams, published in Cracow in 2001, with some additional information reported in Budding and Butland's (2011) article (see bibliography). The adopted formula was

Min I = JD Hel 2445391.265 + 1.13594233 E

The scale of the radial motion implied by the O – C curve, if it were to take place in the plane of the sky, would incur movements in the range of hundreds of milliarcsecond (mas). This teeters on the edge of what can be successfully measured by traditional ground-based astrometry. Such measures were significantly enhanced in precision by the HIPPARCOS satellite that Ribas et al. included in their work, although its contribution, for a system with a ~93 yr period orbit, is really just as a snapshot.

Ribas et al. discussed the numerous historic, accurately determined, positional measures of R CMa in the sky. As a result, they argued for the presence of a third body of 0.34 solar masses, in an appreciably eccentric (e = 0.49), orbit, nearly coplanar to that of the close binary, of period around ninety years, with an angular semi-major axis of about 120 mas. Ribas et al. retained the same low total mass of the close binary as Tomkin (1.24 $M_\odot$), emphasizing the significance of their approach to future studies, including those of exoplanets.

The analysis of Ribas et al. sought a non-linearity in the proper motion of the star, associated with the wide orbit motion. They combined this with the suitably weighted historic and HIPPARCOS positional data, and also the O – Cs, in one large least-squares reduction for 14 independent parameters. Butland and the present author produced a separate model from the O – C curve that they adopted, using the positional data to derive only the two parameters: nodal angle and wide orbit inclination. Both analyses resulted in a sub-solar mass to the wide companion, though the latter authors found a significantly higher mass and more luminous third star than Ribas et al. Budding & Butland's model fitted better with the low level of third light claimed by Watson Varricatt and N. M. Ashok in their photometric analyses of R CMa, that included their new LCs in the J and K bands.

The problem that has arisen since 2011, however, is that although Figure 3 appears persuasive as a LTT effect, follow-up research has failed to confirm the existence of a wide component in the R CMa system, at least in the form proposed by these earlier studies. The system has been more recently observed with many individual images included and at higher resolution. The predicted Main Sequence K0 type companion ought to have shown metallic lines and a RV signature close to the systemic velocity of the close pair, but these have simply not been seen. Any additional continuum apart from the contributions of the close pair was also not confirmed in subsequent observations.

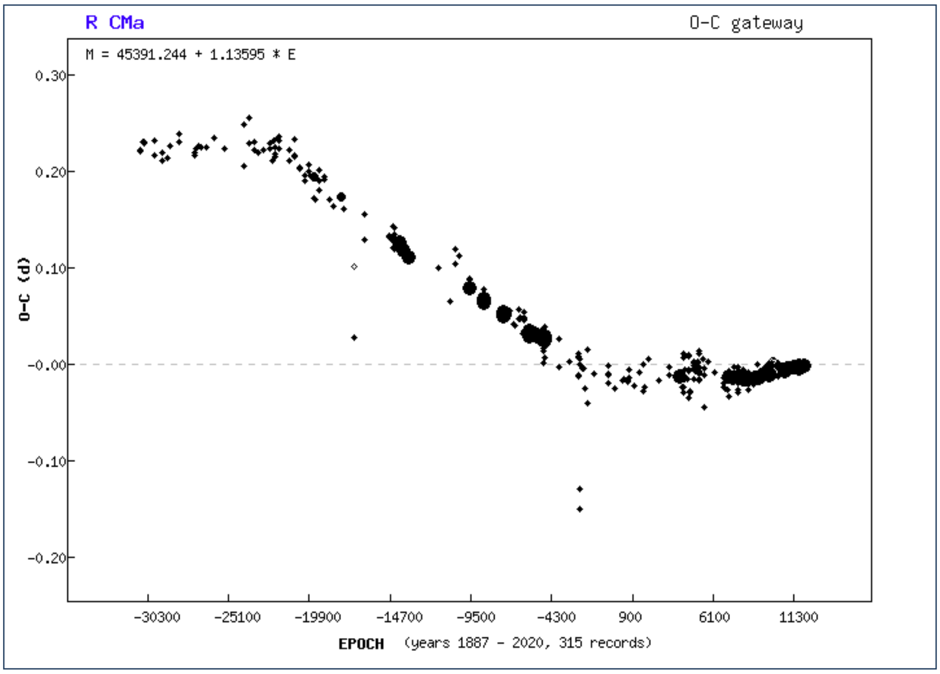

Figure 4. *O – C diagram calculated with the ephemeris parameters given on the `O – C Gateway' webpage and in the top left of the diagram. The different parameters result in a different shape to the trend from that of Figure 3.*

The implication would then be that Figure 3 does not correspond to an LTT effect; though this raises the question of what other process might give rise to such an O – C variation. Here we should also recall that the shape of the O – C curve depends on the adopted ephemeris. This is apparent from a comparison of Figures 3 and 4, and it bears out conventional wisdom that cyclic effects reported for O – C diagrams should be confirmed from at least one complete repetition of the cycle.

Meanwhile, a recent Gaia data release (DR2) indicates the presence of a third object accompanying the close binary R CMa at an estimated distance of about 1.75 AU, though this is a body of planetary mass – some 26.11 times that of Jupiter!

As an additional line of thought, in their extensive review of evolution scenarios for contact binaries, Kadri Yakut and Peter Eggleton consider various possibilities for the evolution of close low mass pairs engaging in interactive evolution. These binaries face a dilemma imposed by the requirements to satisfy the conditions for equilibrium within the common envelope and the different conditions for regular star-like internal structure and energy production. The result is a process of 'thermal relaxation oscillations', wherein the component stars move into and out of a common envelope phase on a relatively slow (thermal) timescale. R CMa type systems may evidence part of such a cycle; however, the frequency of incidence does not match (apparently, too many observed common-envelope binaries compared to R CMa binaries), while alternative scenarios for over-contact binaries exist that do not involve an Algol type condition.

It seems difficult to reconcile the various strands of evidence on this puzzling system with one coherent model at the present time and further observations, of the kinds mentioned above, and otherwise, are called for.

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Period change analysis of V0625 Carinae – *Mark G Blackford & Tom Richards*

V0625 Carinae (NSV 4657, ASAS J095048-6723.3) is a W Ursae Majoris-type (EW) eclipsing binary for which AAVSO's Variable Star Index (VSX) lists a V magnitude range of 11.15 to 11.94, period 0.276943 d (6.6466 hr) and zero epoch 2451868.235 HJD (19 Nov 2000). It has received very little attention due to its far southern declination of -67.4 degrees.

The VSX describes EW binaries as consisting of ellipsoidal components almost in contact and having light curves for which it is impossible to specify the exact times of onset and end of eclipses. The depths of the primary and secondary minima are almost equal or differ insignificantly. Light amplitudes are usually <0.8 mag. in V. The components generally belong to spectral types F-G and later.

A light curve obtained by MGB on the night of May 6th 2019 is shown in Figure 1. Both primary and secondary eclipses are quite deep, allowing accurate minima timings. There is a small difference in brightness between the two maxima, a phenomenon known as the O'Connell effect. This is usually taken as evidence for bright or dark spots on one of the stars in the system.

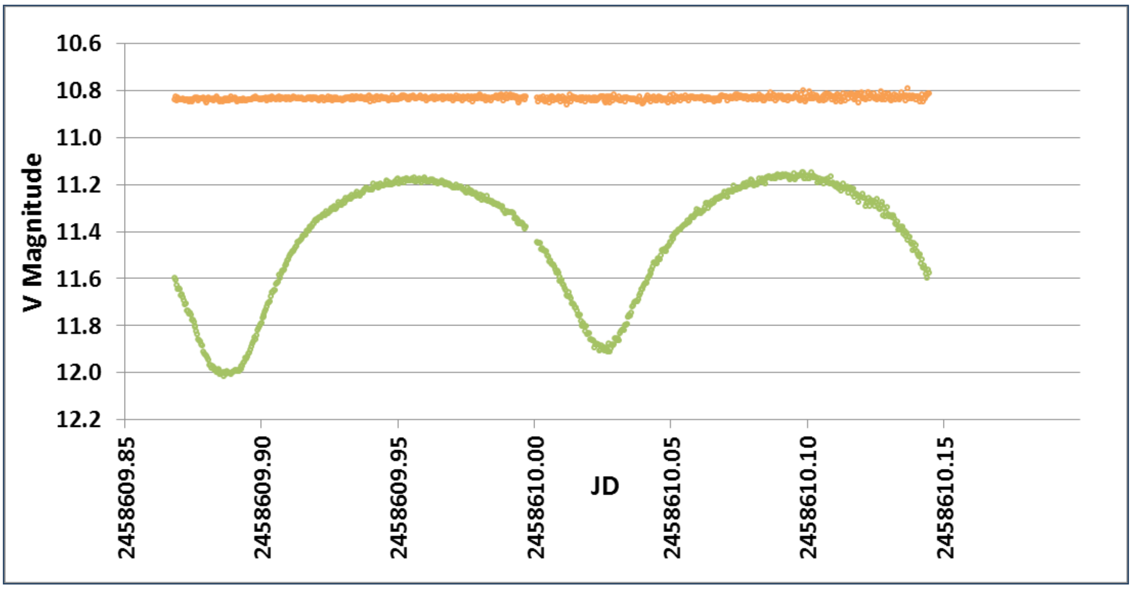

Figure 1. *V0625 Car (green) and Check star (orange) light curves.*

As with many southern eclipsing binaries, the period and zero epoch, together known as the Light Elements (LEs) were derived from All Sky Automated Survey (ASAS) observations. The VSX LEs are from Pilecki et al. (2007) who presented 31 bright eclipsing contact and semidetached binaries that showed high period change rates in a 5 year interval in observations by the ASAS. Pilecki et al. (2007) reported the rate of period change of V0625 Car to be -0.07(2) x 10^{-5} d yr^{-1}.

In this article we extend the observational time base from 5 years to 21 years and explore the nature of the purported period change.

All published eclipse times of minimum (ToMs) are listed in Table 1. Additional epochs were derived from ASAS, All Sky Automated Survey for Super Novae (ASAS-SN) and Transiting Exoplanet Survey Satellite (TESS) observations using the technique described in Blackford (2022).

Table 1. *V0625 Car times of minimum and O-C values calculated using VSX epoch and period.*

HJD of min	HJD error (d)	Eclipse Type	Observer/Source	O-C (d)	Cycle	Date (UTC)
2451868.2350		P	VSX	0.0000	0	2000-11-19
2452080.3747	0.0022	P	ASAS	0.0013	766	2001-06-19
2452684.6654	0.0023	P	ASAS	0.0024	2948	2003-02-14
2452783.5350		P	Otero / IBVS5495	0.0034	3305	2003-05-24
2453036.6589	0.0024	P	ASAS	0.0014	4219	2004-02-01
2453661.7182	0.0018	P	ASAS	0.0003	6476	2005-10-18
2454291.4860	0.0023	P	ASAS	-0.0003	8750	2007-07-09
2454921.6721	0.0023	S	ASAS	0.0021	11025.5	2009-03-31
2454973.5970		P	Samus / GCVS	0.0001	11213	2009-05-22
2457151.9129	0.0001	S	Pavlov / Bob Nelson file	0.0209	19078.5	2015-05-09
2457461.7726	0.0500	S	Chiavassa / OEJV0179	-0.0186	20197.5	2016-03-14
2457719.7845	0.0023	P	ASAS-SN	0.0209	21129	2016-11-27
2457724.7707		P	Kochanek ASAS-SN / O-C Gateway	0.0221	21147	2016-12-02
2458144.6193	0.0021	P	ASAS-SN	0.0251	22663	2018-01-26
2458192.9476	0.0005	S	Blackford / OEJV0198	0.0269	22837.5	2018-03-15
2458193.0864	0.0005	P	Blackford / OEJV0198	0.0271	22838	2018-03-15
2458195.0251	0.0007	P	Blackford / OEJV0198	0.0273	22845	2018-03-17
2458195.1634	0.0005	S	Blackford / OEJV0198	0.0271	22845.5	2018-03-17
2458195.9942	0.0005	S	Blackford / OEJV0198	0.0270	22848.5	2018-03-18
2458196.1328	0.0005	P	Blackford / OEJV0198	0.0272	22849	2018-03-18
2458215.9346	0.0005	S	Blackford / OEJV0198	0.0276	22920.5	2018-04-07
2458216.0727	0.0006	P	Blackford / OEJV0198	0.0272	22921	2018-04-07
2458581.3655	0.0000	P	TESS S10	0.0321	24240	2019-04-07
2458601.9966	0.0004	S	Blackford / JAAVSO48	0.0310	24314.5	2019-04-28
2458608.7819	0.0000	P	TESS S11	0.0312	24339	2019-05-05
2458609.8896	0.0004	P	Blackford / JAAVSO48	0.0311	24343	2019-05-06
2458610.0278	0.0005	S	Blackford / JAAVSO48	0.0309	24343.5	2019-05-06
2459251.0205	0.0008	P	MGB / not yet published	0.0390	26658	2021-02-05
2459292.8396	0.0003	P	TESS S36	0.0397	26809	2021-03-19
2459318.8726	0.0003	P	TESS S37	0.0401	26903	2021-04-14
2459346.2902	0.0003	P	TESS S38	0.0404	27002	2021-05-11

IBVS = Information Bulletin on Variable Stars; GCVS = General Catalog of Variable Stars; O-C Gateway; OEJV = Open European Journal on Variable Stars; JAAVSO = Journal of the American Association of Variable Star Observers.

The Observed minus Calculated (O-C) diagram using all Table 1 values is shown in Figure 2. The Pavlov and Chiavassa values are plotted as red squares and are considered to be anomalous as they clearly do not fit the trend of other data points. Chiavassa's reported error estimate is very large. The original reference for the Pavlov ToM could not be found.

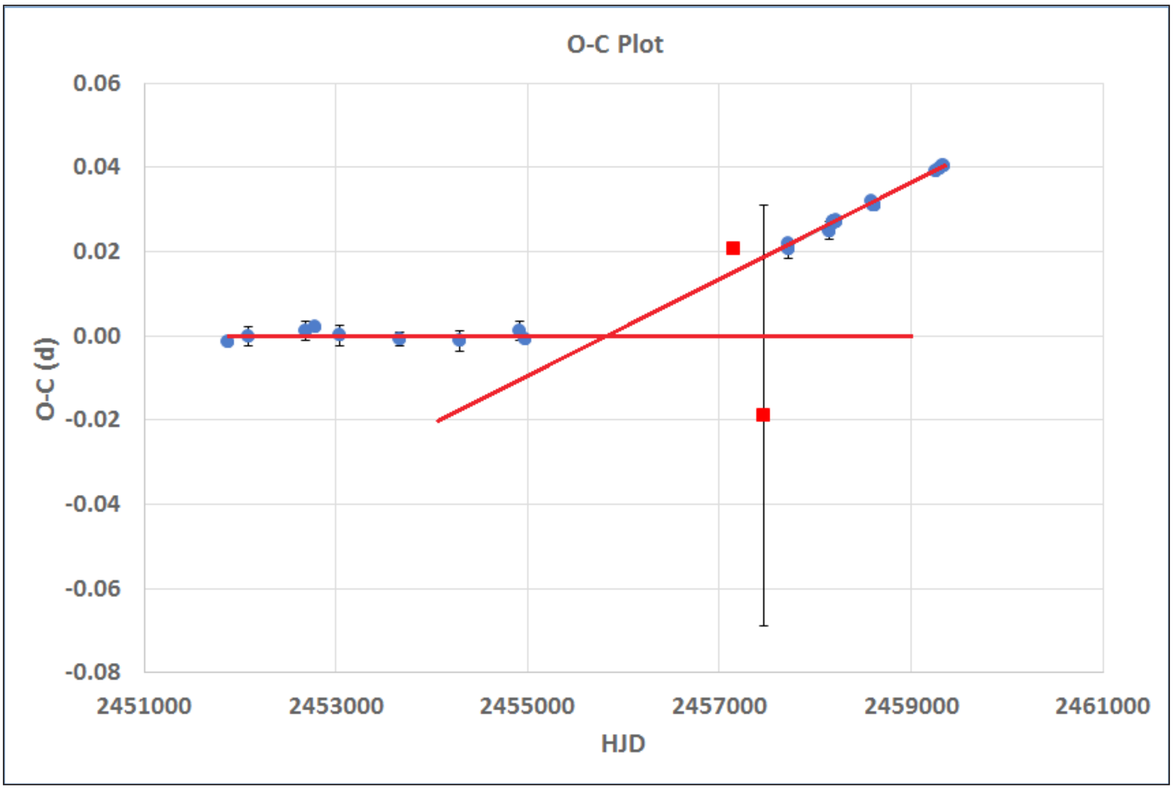

Figure 2. *V0625 Car Observed minus Calculated diagram using VSX epoch and period.*

Prior to HJD 2455000 the O-C values are very close to zero and fall along a horizontal straight line confirming that the VSX epoch and period were essentially correct for those early observations.

After HJD 2457700, however, the O-C values fall along an inclined straight line indicating that the period was constant but slightly longer.

Linear regression of the early and late groups of data separately yields the following refined light elements:

pre-HJD 2455000	epoch HJD 2451868.2366(7)	period 0.27694293(11)d.
post-HJD 2457700	epoch HJD 2457719.7850(2)	period 0.27694620(7)d.

Extrapolation of the two linear trends (red lines in Figure 2) suggests the period change occurred at about HJD 2456000 (early 2012). Unfortunately we were unable to find any observations around that time.

Discussion and conclusions

The orbital period of the W Ursae Majoris-type eclipsing binary V0625 Car underwent a sudden change at around HJD 2456000 (early 2012). From late-2000 until mid-2009 the period was constant at 0.27694293(11) days, from late-2016 to mid-2021 it was constant at 0.27694620(7) days. The period change may have resulted from a rearrangement in the core of one star as it accreted material from the other.

Mallama and Pavlov (2015) reported V0752 Cen underwent a similar large orbital period increase in 2004 after a span of at least 34 years when it had not changed perceptibly. Yu et al. (2015) found that the orbital period of YY CrB shows either a long-term period decrease and a sinusoidal oscillation, or an abrupt change, which can be explained by mass transfer between the components and the magnetic activity of the system.

Acknowledgements

This research made use of the AAVSO VSX database and the SIMBAD and VIZIER databases, operated at CDS, Strasbourg, France and of NASA Astrophysics Data System Bibliographic Services. This paper

includes data collected by the TESS mission, which are publicly available from the Mikulski Archive for Space Telescopes (MAST) and the ASAS survey available through the AAVSO's VSX database. This research made use of Peranso (www.peranso.com), a light curve and period analysis software and VStar software.

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QZ Carinae - a part of the riddled solved – *Stan Walker*

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Some backgound

This project began way back in about 1967 when Brian Marino and I were measuring eta Carinae visually. There were two comparison stars labelled 64 and we both considered them variable. But when this was drawn to the attention of Frank Bateson, Director of the RASNZ VSS, he rubbished the idea, presenting as evidence a paper by two professionals in South America attributing unexplained variations in eta to new observers without the necessary skills.

But patience brings its own rewards. The Auckland Observatory's new UBV photometer was complete, calibrated and producing good results by mid-1970 so we then began measures of HD 93206. These confirmed its variability but with a puzzling pattern - every third night the magnitudes were much the same - we then realised we were dealing with a beta Lyrae variable star with a period close to 6 days. We published this discovery in IBVS 681 in 1971.

I am not greatly interested in discovering new variable stars but if you are in this game then ensure they're interesting. Over the following few years a wide variety of professionals observed QZ Carinae and described its attributes. Even today, a paper by Peter Harmanec draws attention to various other faint stars, believed to be members of the QZ Carinae system. Three of the four main stars have O spectra, the other early B and all are supergiants so the total mass of the system appears to exceed 100 solar masses. At ~7000 light years it's still bright enough at maximum, V = 6.2 to be on the verge of naked eye visibility.

Light time effects

The major components comprise two pairs with periods of approximately 6 and 21 days - the first of which is eclipsing and being used as our marker. These pairs are in orbit around a common centre of gravity - the long period orbit. So, as they move away from the observer the light time effects are positive and the ~6 day period appears longer, as they approach it appears shorter. These can be plotted against the assumed period of the ~6 day pair which Pavel Mayer in 2000 deduced to be 5.99857 days. This has formed the basis for the Observed-Calculated plots of Figures 1 & 2. Figure 1 was compiled in August 2021. The vertical axis is O-C in days, and the horizontal axis is in Julian Date-2400000 (MJD).

Dave Blane of South Africa has continued measures and I have recently added a point for cycle 3097 (an average over the 2021-22 season) which is shown in Figure 2.

This illustration is interesting in that the last three measures appear to show a flattening out of the O-C curve indicating that, apart from the displacement caused by a period slightly different from that derived by Mayer, and used by us, the shape of the curve may be approaching that of 1982 (about MJD 45000 in this plot). Thus, we can try to match the beginning and end parts of the O-C curve.

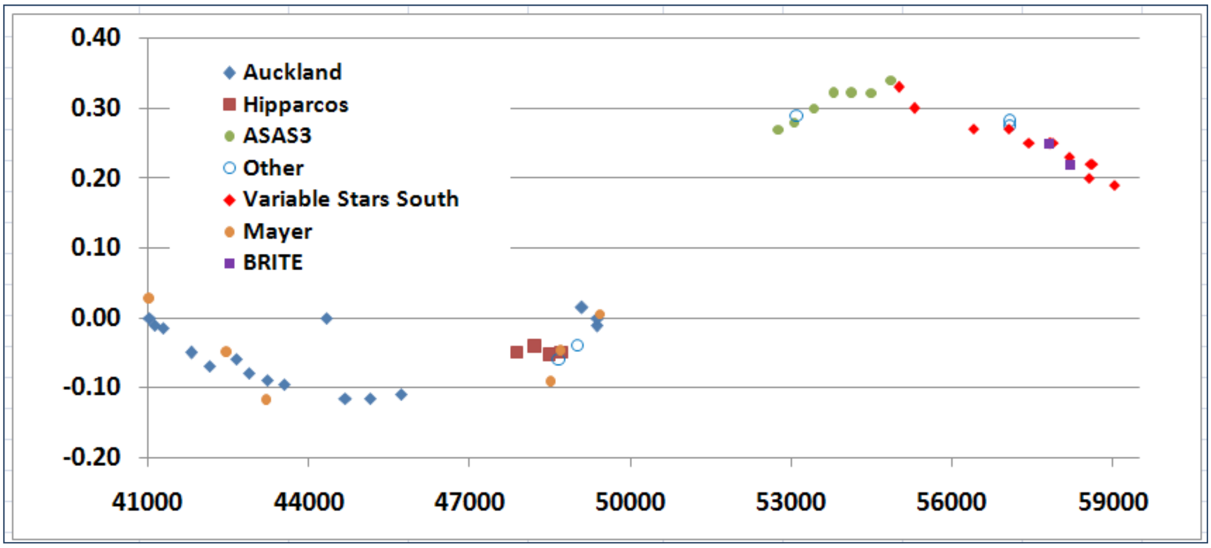

Figure 1. *O–C graph for the the 6-day period pair of stars in QZ Car, based on Pavel Mayer's period value of 5.99857 days from the year 2000.*

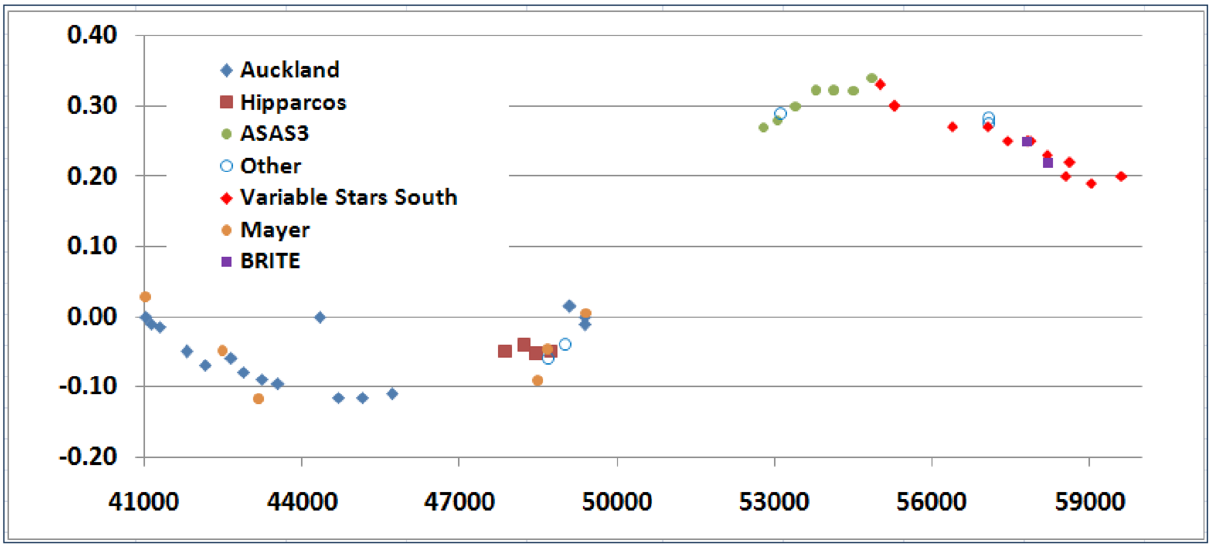

Figure 2. *Same as Figure 1 but with an additional point for the 2021-22 season.*

This necessitates determining the fundamental period which now appears to be 5.99867 days. The derived epochs are then fitted to the phase diagram shown in Figure 3, where the horizontal axis is phase, in this case with a period of 15,500 days or 42.4376 years, with the first epoch in 1971 as the zero epoch. There is an overlap from phase 0.0 to 0.20.

Note that slight change in period affects the relationship of the last few points a little. In this graph only those epochs derived from available measures have been used so several points from Mayer have been omitted.

If the curve derived from the light time effects is now overlapping in a second cycle measures during the next few years will be very interesting. The system is at opposition in late March but is circumpolar for many of our members, particularly those south of 40S latitude. So, are there observers out there who can help? For CCDs it means stopping down the telescope to about 80mm which is easily achieve using an off-centre cardboard disc in front of the corrector plate. The comparison stars are HD 93695 V = 6.469, B-V = -0.121 and HD 93131 6.483, -0.011. Like most blue stars they have been reported as variable, but Hipparcos gives an error of 0.007 for the former and 0.011 for the latter which is a Wolf Rayet star and is apparently variable with a range of 0.01 or so which is trivial in this case. HD 93695 is a foreground star; the other is heavily reddened at about the same distance as QZ.

The method of deriving seasonal epochs is shown in Figure 4 (vertical axis is V magnitude and the hor-

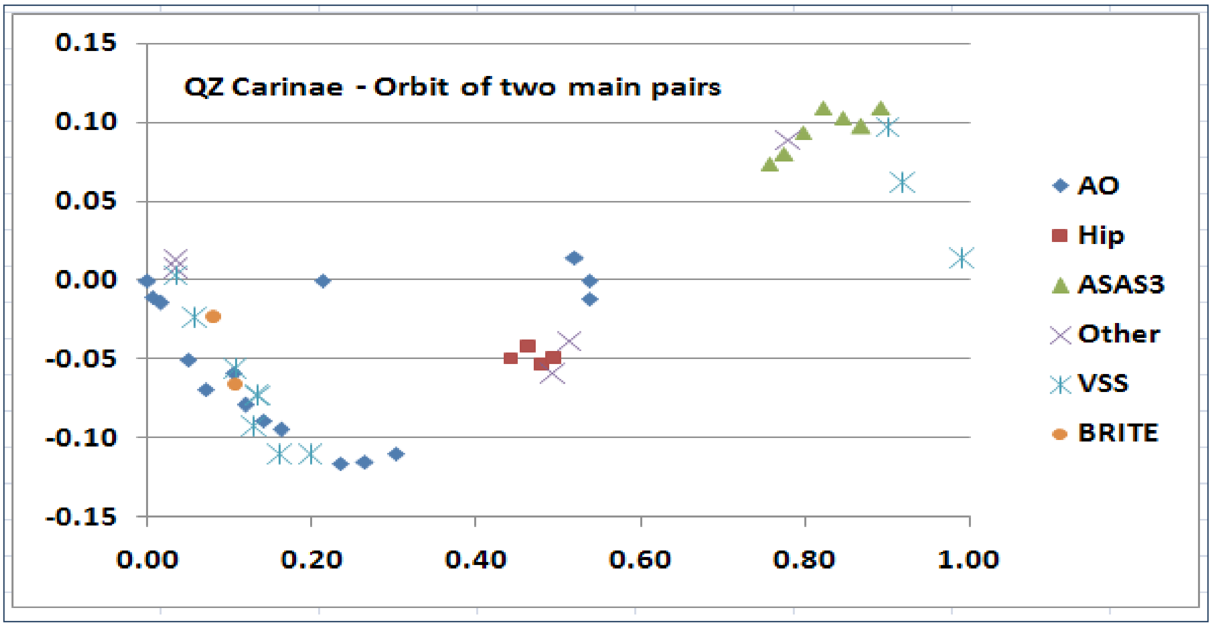

Figure 3. *O-C plaotted againsts phase for the 6-day period pair in QZ Car.*

izontal axis is phase). Series 1 are points making up the mean light curve (MLC) derived from measures by the BRITE satellite, series 2 are individual measures by Dave Blane in 2019 and series 3 are means of the six blocks into which the ~6 day period forces measures from any one location.

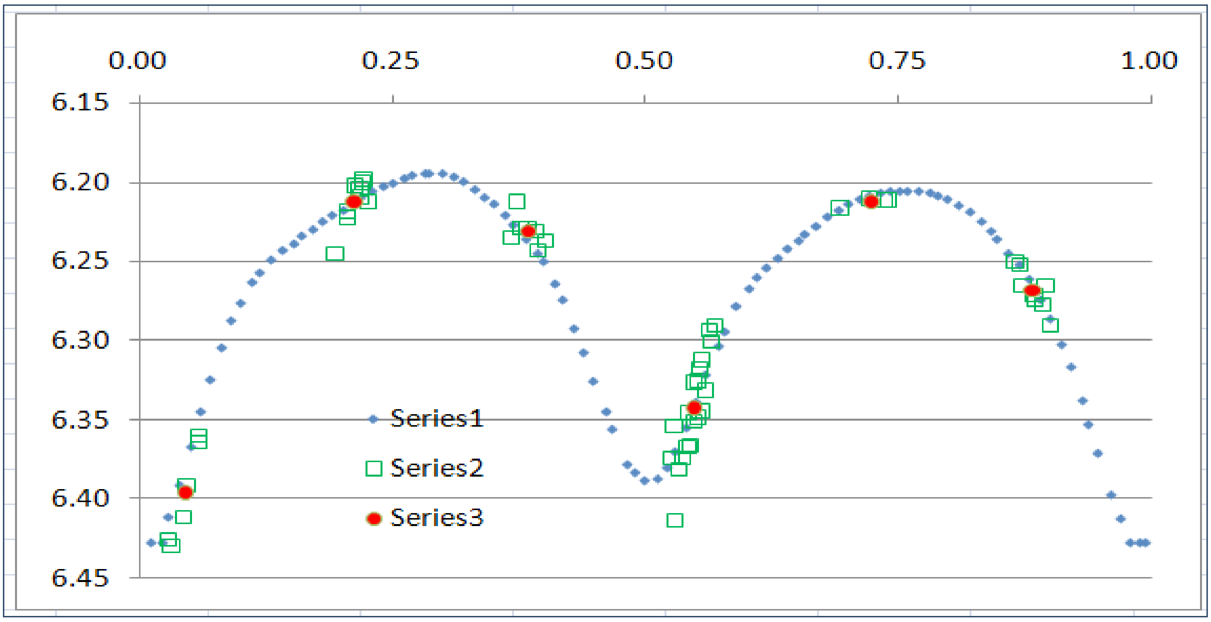

Figure 4. *Magnitude vs phase diagram for the 6-day period pair of stars in QZ Car.*

About 20-30 individual measures (there is no real advantage in long time series monitoring as the amplitude is low and changes little in a night) fully transformed would be very welcome. More are preferable. This may take five or ten minutes at most on a good night. Don't hesitate to contact either me or Mark Blackford if necessary.

This system of stars is one of the most massive and luminous in our galaxy and is still not fully understood or described. If, over the next two years or so, the light travel time curve can be confirmed as now repeating itself this would be a significant contribution to this understanding. Measures should be sent to the AAVSO International Database, but I would be grateful if they were sent to me as well.

Reference

P. Mayer, R. Lorenz, H. Drechsel and A. Abseim. *The early-type multiple system QZ Carinae. A&A 366, 558-564 (2001*

Time series photometry of bright stars with the Star Adventurer Pro - *Roy Axelsen*

In recent years I have used a SkyWatcher HEQ5 Pro equatorial mount with either an 80mm or 120mm refractor for time series photometry. The go-to capability of the HEQ5 Pro and plate-solving software made target acquisition easy. However, because I have never built an observatory the equipment must be set up rather laboriously for each observing session and disassembled afterward, although in extended periods of good weather it remains outside for several days and nights covered with a sheet of thermal curtain lining during the day for protection from the sun. We will at some stage move from our present home into something smaller, where storage of a standard telescope and mount may be problematical and where a simpler and smaller setup would be an advantage.

I had considered the Star Adventurer for a while, but was concerned about the fact that it is not a go-to mount, and about how to balance a DSLR camera with a heavy Canon EF 200mm f/2.8 L lens, which had no tripod collar when I purchased it second hand a few years ago. After I had sourced a tripod collar and read how to go about balancing various types of equipment, I took the plunge and bought the mount. The price was only several hundred dollars. I believe it is the best investment in equipment I could have made at this stage of my life for bright star photometry (stars to 9th magnitude) because it works, and is quick and easy to set up and to dismantle. This article describes how it is configured for my equipment, how I use it, and examples of results from a few sparse nights' observing gleaned during a very wet and cloudy summer.

Equipment and setup

I purchased the SkyWatcher Star Adventurer 2i Pro Pack, a boxed set of components, which can be selected and assembled on a sturdy camera tripod in a range of configurations. It is assumed here that an equatorial wedge (in the pack) is used. The simplest configuration involves setting up a DSLR camera with a short focal length lens on the mount, acquiring a camera-specific cable (not in the pack) to connect the camera to the mount and setting the functions so that an astro image is captured automatically every 100 seconds and saved on the camera's SD card. The more complex setups require a counterweight bar and counterweight (both in the pack), and allow the user to image through one small telescope or even two small telescopes side by side, as long as the load is within the specified limits and can be balanced in RA and DEC. Accessories not included in the pack, for example an Arca Swiss plate and clamp which are available or obtainable by order from camera shops, may be necessary to balance some setups in DEC. Instructional videos, which I regard as essential, are easily found on the Internet.

My initial intention was to mount a DSLR camera and 200mm camera lens on the Star Adventurer. However, I also have a ZWO ASI1600MM cooled monochrome CMOS astronomical camera and a ZWO electronic filter wheel fitted with Johnson B and V photometric filters and R, G and B astrophotography filters, and decided to use that instead. ZWO supplies an adapter for Canon EOS lenses that screws into the filter wheel. I now have the camera, filter wheel, adapter for the Canon lens (all from ZWO) and the 200mm lens itself on the Star Adventurer (Figure 1). The equipment sits in a corner of our study on a camera tripod. It can be picked up and carried outside to my observing

Figure 1. *Camera, filter wheel, ZWO Canon EOS adapter, and Canon 200mm canon lens on the declination fine tuning component of the Star Adventurer.*

area, although I usually detach the camera, filter wheel, adapter and lens (in one piece) before moving the equipment, then reattach them when outside.

Figure 2 shows the full setup and how tracking in RA may or may not be limited, depending on the declination of southern targets. The left panel of Figure 2 show the camera aimed at a target to the south east or east south east. In the middle panel, the camera has been moved manually in RA through the meridian to aim well to the west. Neither the camera nor the cables will collide with the mount and no meridian flip would be needed. In the right panel, the camera was aimed at a target further to the south then manually swung through the meridian to the west. Any further motion to the west would cause the cables to collide with the mount.

Figure 2. *ZWO ASI1600MM camera, ZWO filter wheel, ZWO EOS adapter and Canon 200mm lens on the Star Adventurer, with cables attached to the camera. The dew heater has been omitted for this demonstration. The middle panel shows that, provided the target is not too far south, slewing in RA avoids a meridian flip, and avoids any collision between the camera + cables and the mount. The panel on the right shows that, for more southerly targets, tracking past the meridian will not be free of collisions in the configuration illustrated.*

To avoid the problem illustrated in the right panel of Figure 2, first of all position the equipment upright, with the camera and lens at the top, and the counterweight down. For a target in the south east, initially aim the camera at the south west (yes, I know that is not intuitive), then loosen the RA clutch, and manually move the camera to the east until the position is as shown in the left panel of Figure 3. Set the position of the camera to point at the declination of the target (see how to do this below in the section Target Finding). Once that is done, manually slew the camera to the west to check that the cables are well clear of the mount (middle and right panels of Figure 3). Then, aim the camera at the RA of the target.

Polar Alignment

The Star Adventurer has a polar 'scope, but I prefer to align by star drift. I find that if there is no perceptible movement of stars to the north or south when the interval between successive exposures is 2 to 3 minutes, there will be hardly any north or south drift over several hours of imaging.

Figure 3. *Configuration for a target more to the south, to allow tracking without any collision between the camera or cables and the mount, and thus without a meridian flip.*

Target Finding

As the Star Adventurer is not a go-to mount, the camera is first manually aimed at the approximate position of the target. Displaying an ASCOM telescope simulator on a computer screen assists in this procedure (Figure 4). The only purpose of the display is to see the LST (local sidereal time), which updates continuously. If, for example, the target was at 11 hours RA, and the LST was 7 hours 6 minutes, the mount would have to be slewed nearly 4 hours in RA to the east. It is easy to judge this angle approximately. The declination is likewise set approximately. The mount is then turned on, set to track in sidereal mode, and an image taken. Plate solving displays the RA and DEC of the centre of the image. I use All Sky Plate Solver, run within the image capture software Astrophotography Tool, which solves one image in 15 to 30 seconds. The mount is then adjusted manually to point closer to the position of the target. Another image is taken, plate solving repeated and the mount adjusted again. I find that it is best to loosen the RA clutch and carefully move the camera manually until part of the target field of view is recognizable in the image. Smaller adjustments in RA are easily done with the 'fast' slewing buttons, one for each direction, with a slewing rate is 12 time sidereal. In DEC, swinging the camera through large angles is best done by slightly loosening the screw attaching the camera to the DEC axis, and moving the camera manually. Once pointing in DEC is only a few degrees from the target, the fine tuning knob (see Figure 1) makes adjustments very easy.

Figure 4. *ASCOM telescope simulator, to display the LST (local sidereal time).*

Image Acquisition

Although it is possible to autoguide (in RA only) with the Star Adventurer, I chose not to do so to simplify the setup. With the equipment described, exposures up to 2 minutes show no star trailing, although obvious periodic error is evident when viewing a quick scan of a series of images.

The ZWO ASI1600MM is a 12 bit camera. My preferred procedure is therefore to set the gain to 139 dB units (unity gain, 1 electron per ADU), defocus the images, and set the exposures by trial and error so that the brightest star in the sequence has a 'high' maximum ADU count but is not saturated, and judged to remain unsaturated through meridian passage. Checking for saturation is easy in AstroimageJ, as hovering an aperture cursor over a star image instantaneously displays the maximum ADU within the aperture.

Test images are unbinned, because binning 2x2 (or more) results in mathematical averaging of the ADUs of the pixels in each bin. Unrecognized saturated pixels (i.e., true physical pixels) could therefor occur in binned images. The science images, darks and flats are, however, binned 2x2 to conserve disk space and to enable rapid processing of the images, as the binned image file size of 8 MB is one quarter of the file size of unbinned images.

Images are captured through a red astrophotography filter because the transformation coefficient Tr_vr is very close to zero. Non-transformed magnitudes of standard stars determined with this filter are close to catalogue Cousins R magnitudes. As the main purpose of my photometry is to determine the times of mid eclipse, I accept small errors of magnitude determination. Because measurements are made in red light, differential extinction across the field of view is minimized. Extinction coefficients are not used.

Light curves of eclipsing binary stars

Acceptable light curves have been obtained for the contact binary stars S Ant and V362 Vel, with one example for each star shown in Figures 5 and 6. The V362 Vel light curve is truncated somewhat on the right, because I wanted to capture an eclipse of another binary system later in the night.

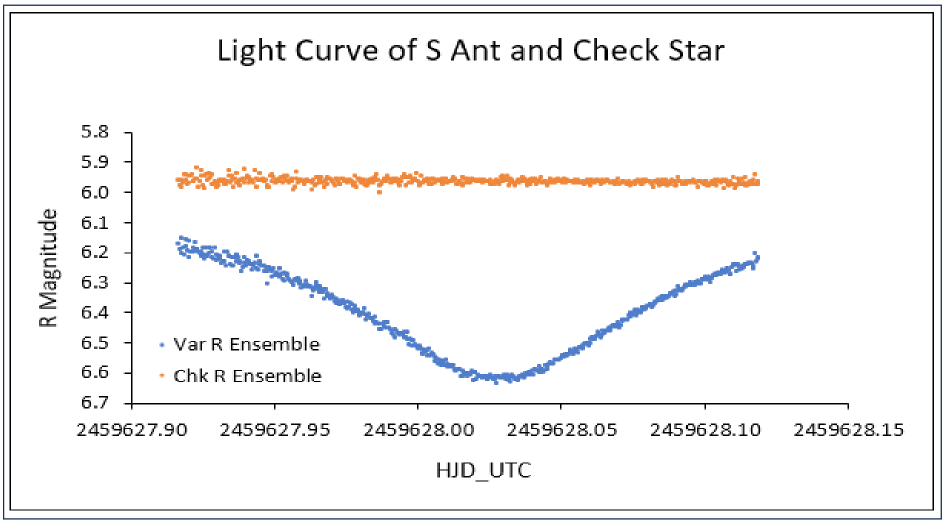

Figure 5. *Light curve of S Ant and check star from the night of 17 February 2022.*

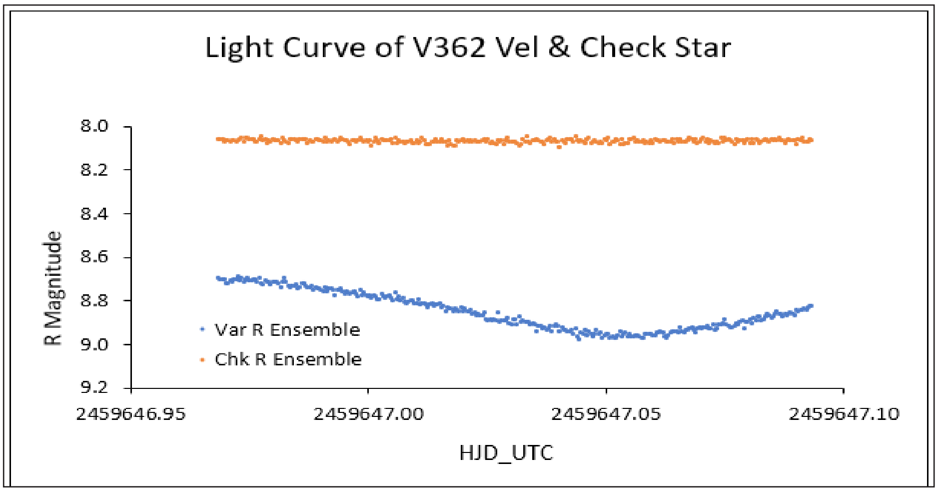

Figure 6. *Light curve of V362 Vel and check star from the night of 8 March 2022.*

Conclusion

The Star Adventurer Pro is an equatorial mount for light-weight equipment. It is relatively quick to set up and dismantle, but does not have go-to capability and thus target finding can take extra time. An important advantage for time series photometry of variable stars is that the setup can be configured so that imaging can continue through meridian passage without the need for a meridian flip.

Cepheids & period changes – *Stan Walker*

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Introduction

With advancing age I find that the demands of observing are too great so I'm spending what time I have for astronomy on various astrophysical analyses. An area I have been involved with for more than 40 years involves Cepheids and their period changes.

Another development has been the setting up of the International Database, maintained by the AAVSO but containing the observational records of most of the amateur societies. Some aspects of this are not ideal, such as the separation of V, B-V and U-B into the actual filter bands, leading to the inaccuracies with S Orionis discussed in the January, 2020, newsletter. But as a historical record of Cepheid observations it is a great place to look.

Visual measures

Are visual measures accurate enough for the study of Cepheids? Visually, these stars show light variations of up to 1.5 magnitudes in a strongly repetitive manner with cycles up to ~45 days. A star with a longer period, S Vulpecula, has been described as both a Cepheid and an SRd variable and other objects in external galaxies with even longer periods are noted as Cepheids. Certainly S Vulpecula does not show the normal Cepheid regularity.

I'll return to this question of accuracy later in this article but provided that care is taken and the comparison sequence is well selected and accurate then 0.1 magnitude accuracy should be achievable visually. This would suggest 12 to 15 brightness points on each branch of most longer period Cepheids. Quite a luxury!

Cepheids are largely galactic plane (Milky Way) objects. So in most cases there is a season of six to eight months each year for observing.- it is thus convenient to use annual epochs. The best epochs require about 30-40 measures with good coverage of the rising light curve. A helpful feature is that the longer period stars have shorter rise times each cycle - U Carinae's rise is 0.21 phase - so if this part is well covered accuracy is high - but only if enough of the light curve is obtained to be sure no zero point correction is required. Experience produces accuracy so an observer needs to have made a hundred or two measures before this is obtained.

The seasonal measures are then fitted to a mean light curve using a spread sheet designed by Mark Blackford. A real set of measures is shown in Figure 1. There were 38 measures and only one was discarded by the software - the used measures have a red x superimposed. The blue line is the mean light curve, MLC, based on CCD measures. There is a slight waviness but this does not detract from the fit. A zero point correction of 0.1 magnitudes was needed to align the data with the MLC. The amplitude does not need correction but there's a time correction of 2.5 days. This indicates that the ephemeris of JD 2457817.7222 days and period of 38.83410 was not correct at JD 2446553, 290 cycles earlier. The object here is to determine accuarate light curves for the compilation of an O-C diagram.

The background to the MLC is shown in the two left hand columns. The corrections discussed above are highlighted in green which allows manual input - the amber highlighted values are calculated by the software using the subroutine ***Solver***. My computer uses an earlier version of Solver which does not have some of the functions so I find it easier to do the fit by eye. This means that some of the amber values are incorrect but these are not significant in deriving the epochs. There is also the problem that very noisy data or that with personal idiosyncracies such as rounding off to the nearest half-magnitude may skew the result. The eye can compensate for that by concentrating on the rising branch.

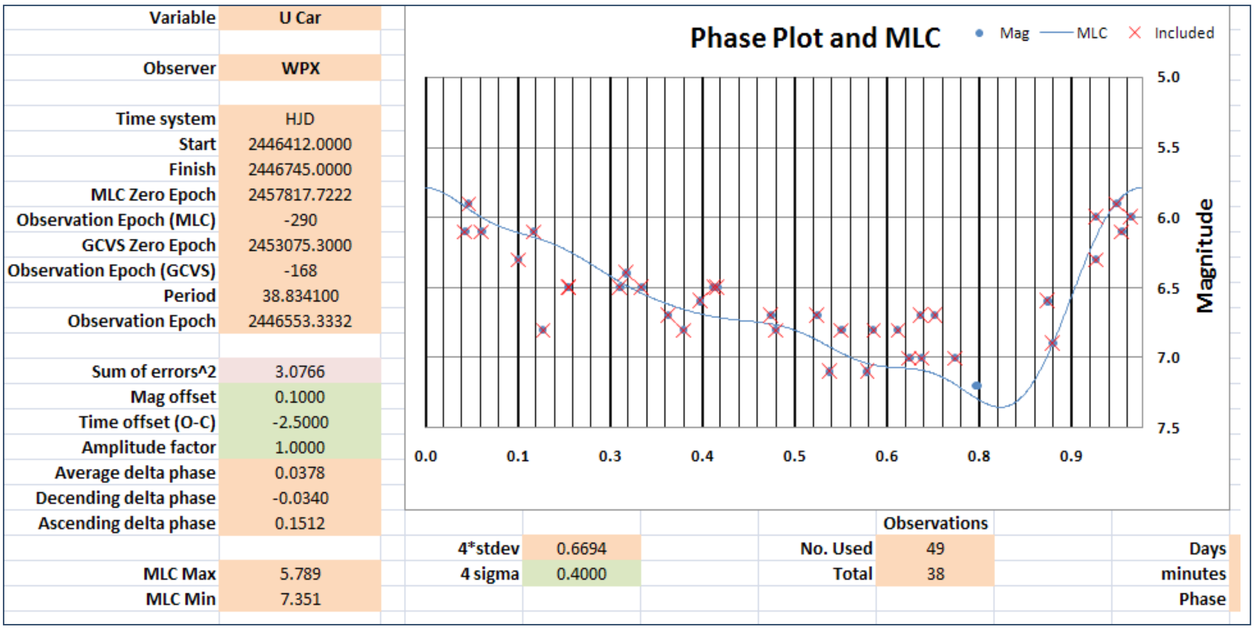

Figure 1. *Mark Blackford's spreedsheet program to determine epochs of maximum. User controlled inputs are highlighted in green, Solver results in amber. See text for other items.*

Problems arising

Let's look at a season's measures of U Carinae by three different observers. This looks a real mess. One observer uses an old RASNZ VSS chart, another a similar one from the AAVSO and the third a chart by a local group. The actual measures have been plotted using the ephemeris JD 2458128.17 + 38.749. If the period is slightly incorrect it does not affect seasonal epochs as there are only 9.425 cycles in a year and aproximately 6 in a season.

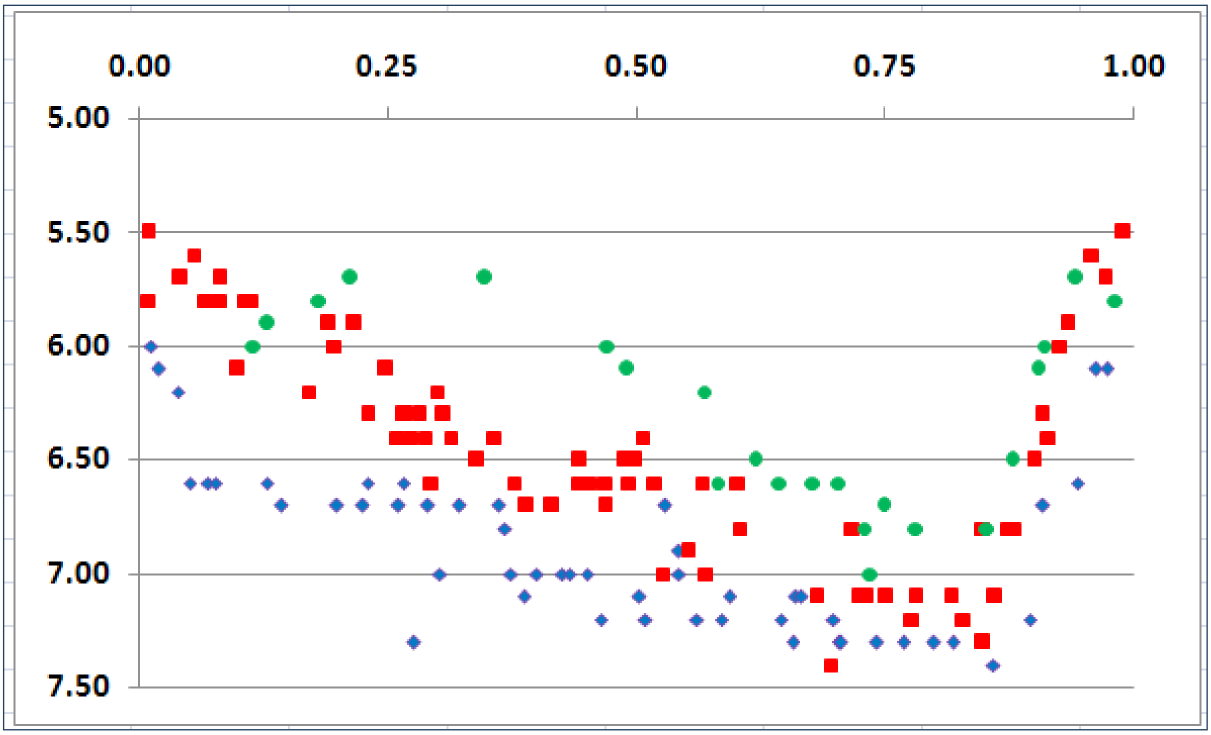

Figure 2. *Raw measures by three different but good observers superimposed. The need to make changes so the results are compatible is quite clear.*

The plot then was then corrected by making two zero point corrections to bring the three sets to the magnitude and shape of the MLC. It seemed unnecessary to stretch or shrink the range with an amplitude correction and a time correction is obviously not necessary as all are phased to the same ephemeris. But the time correction adopted produces a reliable value of the observation epoch. A line fitted to the rising branch was calculated and this showed a standard deviation of 0.011 in phase or 0.426 days. This is adequate in most cases but it could be better.

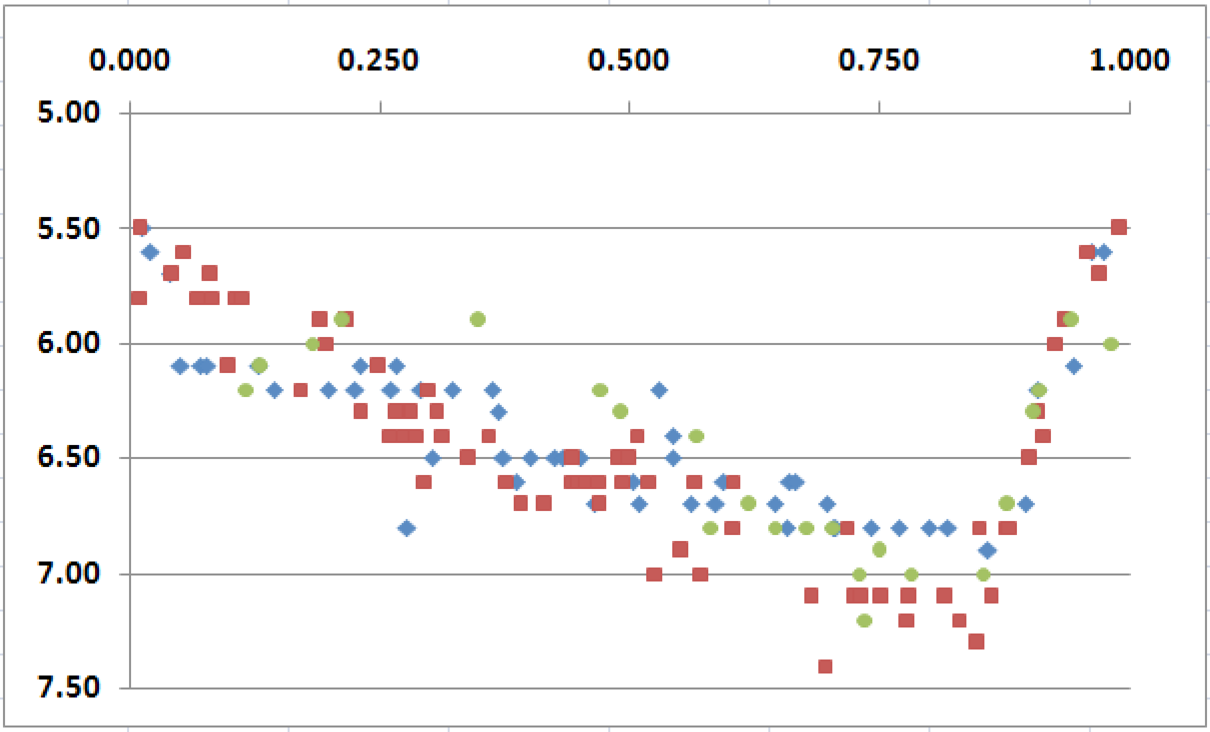

Figure 3. *The data of Figure 2 after corrections necessitated by different comparison star values. Details of these corrections are explained in the text.*

How can we do better? The first improvement is that all observers should use the same comparison stars with the same values. With photoelectric photometry we preferred to determine magnitudes using the same stars and same values adopted by previous observers. The same rule should apply to visual observing. Thus in the case of Cepheids an ideal comparison sequence will contain about 6 stars separated by 0.3 magnitudes for each brightness step.

This also applies to Miras although here the larger range makes for greater magnitude separation in the steps. the lower amplitude semi-regulars would be similar to Cepheids. But the observers are being let down badly by the chart makers. Many charts show far too many magnitudes so that a variety of comparisons with supposedly similar values are available to observers. This wouldn't matter if the magnitudes were very accurate but the published errors show that +/- 0.2 to 0.3 is not uncommon.

There are many Cepheids but their great luminosity means that they're seen at great distances. The number per cubic kiloparsec is not large. So we're concerned with a few dozen bright Cepheids where it should be possible to construct good comparison sequences. But the star we feature here, U Carinae, is so bright that the comparisons are few and well away from the target star. So many observers use binoculars which are probably not as accurate as a small 75mm refractor.

The other impediment is the AAVSO emphasis upon sheer numbers. The RASNZ VSS did not fall into this trap. Analysis of the data shows that some observers tend to prefer 0.5 magnitude steps to save time - so that as many as 40% of the observations are at three of the 11 to 16 possible 0.0 magnitude levels. This negates the value and convenience of using Solver!

Historical

In making this analysis I'm quite intrigued by the reason for obervers to make measures of these stars a century or more ago. The best measures are not random but in many cases there are 30 to 50 per season, often more from 1900 onward. One very prolific observer was Alexander Roberts in South Africa who observed from 1890 to 1922 - with a war going on in that country from 1899-1902.

When we began observing with the RASNZ VSS about 1966 there were only a dozen charts with comparison magnitudes which were not ideal. The earliest computers were crude and expensive and very uncommon - so we calculated periods with simple, manual long division. Mail was good but slow and calls to other countries needed booking. There was obviously no internet. So where did the magnitudes come from?

The earliest measures of the stars I have analysed were of S Vulpecula in 1864 and comprised magnitudes, not the lettered estimates used by the RASNZ VSS and now, it has been mentioned, largely lost as no-one had the time to translate them into magnitudes. I was puzzled as to how such good values were obtained. This question had been answered when Norman Rumsey purchased and donated sets of the Cordoba Durchmusterung, CoD or CD, to the main New Zealand observatories in the 1970s. Even then these were a better source of magnitudes than much of the more modern compilations.

There were several Durchmustering catalogues: the Bonner Durchmusterung compiled in Germany from 1859 to 2003 and the southern extension, the Cordoba Durchmusterung (CD or CoD) resulting from a slightly later Argentine, South Africa collaboration. The CoD catalogue was surpringly accurate for the time and it’s surprising that it was little used by the RASNZ VSS. In the late nineteenth century the Cape Photographic Durchmustering was published. The drawback to this was the blue sensitive film in use which made the magnitude of red stars too faint. Hence the correction needed to the extensive measures of southern variables by Alexander Roberts - but otherwise astronomy owes much to this observer. Even today many stars in the GCVS have photographic (pg) magnitudes containing this error.

PEP and CCD measures

These should be more accurate than visual measures but they come with their own problems. Cepheids are pulsating variable stars and as a result expand and contract, at the same time changing temperature and colours. They’re hottest and bluest very near minimum radius and coolest and faintest near maximum radius. They are normally measured in UBV or BVRI or some combination of filters to allow transformation to the standard system. This normally uses B-V or V-I. Studies of massive compilations by Berdnikov allowed a comparison of these two colours in deriving standard values. Not surprisingly, since classical Cepheid maxima normally occur at F or G spectral wavelengths, B-V is slighty more accurate.

One interesting and confusing result of these measures is that the time of maximum is dependent upon wavelength or frequency. Maximum occurs earliest in U and latest in I of the UBVRI filter system. The time differential is about 2-3 days for stars with a period of ~40 days. This indicates that visual measures have one advantage - they’re all made at much the same wavelength.

A much stronger reason for visual measures is that they are quicker and easier to make and the visual observers tend to stay with the project for decades. PEP and CCD observers do not normally show the same patience. This is even more the case with the now common automatic monitoring projects like ASAS, Hipparcos, TESS, Gaia and similar. These are expensive to set up and operate so they are expected to produce more dramatic results more frequently In this well-studied field of Cepheids these do not seem to occur so the projects move into other areas.

It seems that these ‘electronic’ observers make enough measures to determine the light curve over one or two cycles then cease. Thus the epochs determined are few - not more than five in any of the target stars.

Period changes

This analysis has shown that, unlike Mira and other long period stars, abrupt changes in period are much more common. This is clearly linked to mass and speed of evolution - the intrinsically brighter objects usually showing two or more changes in a century.

Being massive objects there will be more changes in the elements involved in core burning than in the Sun. Each tend to see a reversal of the track in the Hertzsprung-Russell diagram with crossings of the instability strip in both directions. One would expect the period changes to be gradual and to follow parabolic tracks in an O-C diagram but this is not the case - they seem to pulsate steadily at one period until it is necessary to correct some type of lag. I’ve seen no explanation of this.

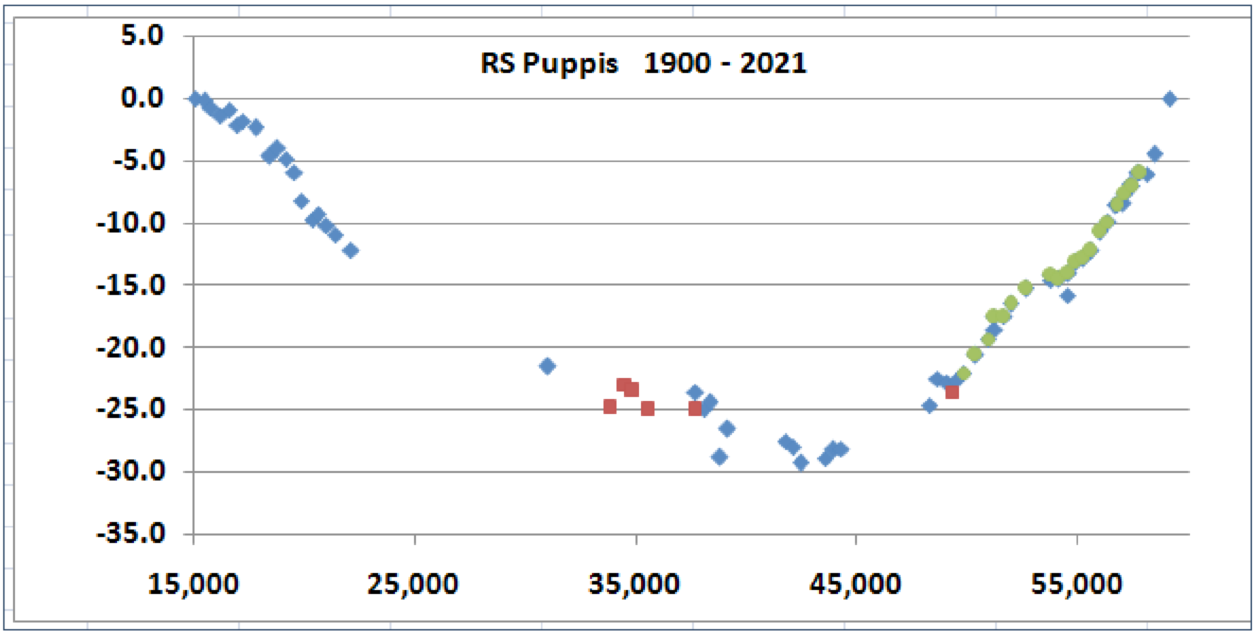

Figure 4. *The O-C diagram of RS Puppis over 121 years. From 1921 to 1978 there were few measures but it's still clear that there was a period change somewhere between 1921 and 1943. A slightly longer period then persisted until about 1980, at which time it lengthened again with a brief return to the earlier period about 2003. The period to 2021 was 41.3444 days after which it lengthened to 41.39575 days and after 1980 to 41.49401 days. The brown squares are PEP measures, the remainder visual.*

RS Puppis is associated with nebulosity which might indicate some degree of mass ejection. Studies of similar period Cepheids show no similar features.

Another interesting feature is a secondary period, much like the Mira period alternations in RASNZ VSS data analysed and discussed in a poster paper at the IAU General Assembly, Tokyo, 1997, and later expanded by Karlsson. This needs many more observations as the cycle lengths are ~5000 days. Only a dozen or so Cepheids have sufficient measures over a long enough time to make this feasible.

Conclusion

This analysis is still in progress and there are other interesting features in several stars. These will be discussed in a poster paper for the RASNZ annual conference in June of this year.

Visual observing of Cepheids provided they are reasonably consistent and accurate are still very valuable and easy to make. The need for consistency in comparison stars is clear if they are to be accurate enough to derive good information on the complex period changes which are occurring. This must be provided by the chart making group who will need to adopt a different approach - only necessary comparisons with highly accurate values should be identified on Cepheid charts.

This particular project has several advantages. The first is the cost saving equipment - a good pair of binoculars or a small 75mm refractor is adequate. But there is nothing wrong with a larger telescope and low power eyepieces. Nor is an observatory needed so you can enjoy the night sky - as I did a few years ago when Comet Hyakutake was rising out of the sea on my north-eastern horizon - a fond memory!

More importantly, however, it is true science. Contact me if you're interested in helping.

Software watch – *Mark Blackford*

Photometric Data Retriever (PDR)

Zejda et al. (2019) point out some of the difficulties associated with accessing data from the many ground and space based photometric surveys. The following is an extract from that paper:

> "The general problem of photometric surveys is that practically each survey or project has its own format of data. Researchers spend a lot of time not only searching the data for selected target(s), but also transforming them into a simple useable format in which they can compare measurements. The time stamps of measurements are, for example, given in somewhat modified Julian Date, numbers of seconds from the beginning of the project measurements and brightness of objects are given in (relative) magnitudes, fluxes or counts.
>
> To increase efficiency of obtaining data, we developed a tool PDR (Photometric Data Retriever) which searches data in selected surveys and if any data are found, then transform them. Right now 15 surveys are bundled with PDR, but it is possible for the user to write a plugin for a new survey and add it to the list. It is possible to search for a star by its name or coordinates and radius. The application gathers data from services such as SESAME and VSX to get as many aliases as possible, as well as other information about the object. After that it uses survey plugins to search for photometric data on the surveys APIs and websites. Data from surveys are transformed into a uniform format and shown to the user in a list with graph (of a phase curve for periodic variable stars). A user obtains data in a uniform Julian Date format, magnitude, and error. No additional correction is applied to the time stamps, thus if original data are with heliocentric/barycentric correction, PDR gives heliocentric/barycentric Julian dates. PDR calculates magnitudes from given fluxes or takes them as they are published in the survey. Original data downloaded from the survey is stored as well and can be easily accessed through the application. All the data found can be exported in multiple ways.
>
> To run PDR you will have to have Java 8+ installed on your computer. The application itself is platform independent, but as of right now there is only the Windows installation package available. It is possible to run the app on Linux or MacOS, it's just not that simple. The application is still under development. The latest version is always available on https://github.com/m-krajcovic/ photometric-data-retriever/releases. The application will automatically update when a new update is available. The only known problem in some searching of data is matching the requested object with objects in surveys, because an astrometry from different surveys is slightly shifted in some cases and also co-ordinates given in SESAME differ from those at SIMBAD or VSX. The system is still in development. Any assistance, notes or recommendation are welcome."

Installation of PDR Version 1.3.22 on a Windows 7 PC went smoothly, the user interface is simple and easy to use. There is no user manual, nor is one necessary to use it for the included surveys. Included in this version of the software are plugins for the following surveys: SWASP, OMC, ASASSN, KWS, NSVS, DK154, APASS, MACHO, ZTF, HIP, KEPLER, KEPLERBC, CRTS, ASAS3, OGLE, OGLE2 and PIOTS. Many of these will be familiar to variable star observers but I'll leave it to the interested reader to research any that they are not familiar with.

The software was tested by downloading available data for several eclipsing binaries; the only problem I found was that ASASSN data was not retrieved. When I asked Dr Zejda about this he replied:

> *"Yes, there is still ASASSN survey, but we have found that if you connect to ASASSN data archive you obtain only "old" data in V band. More data are there available if you use re-processing, but it is not possible to do automatically"*

So if you do try PDR be aware of this limitation. The ASASSN data can be accessed through the External Links section of AAVSO's Variable Star Index (VSX).

Reference

Zejda, M., Skyba, O., Krajcovic, M., Gajdos, P. and Fedurco, M. , 2019, Contrib. Astron. Obs. Skalnate Pleso 49, 132 – 136

Publication watch

Phil Evans was a co-author on one exoplanet paper published on the arXiv.

Sam Christian, Andrew Vanderburg, Juliette Becker, and 111 others *A Possible Alignment Between the Orbits of Planetary Systems and their Visual Binary Companions.* arXiv:2202.00042v1

Abstract

Astronomers do not have a complete picture of the effects of wide-binary companions (semimajor axes greater than 100 AU) on the formation and evolution of exoplanets. We investigate these effects using new data from Gaia EDR3 and the TESS mission to characterize wide-binary systems with transiting exoplanets. We identify a sample of 67 systems of transiting exoplanet candidates (with well-determined, edge-on orbital inclinations) that reside in wide visual binary systems. We derive limits on orbital parameters for the wide-binary systems and measure the minimum difference in orbital inclination between the binary and planet orbits. We determine that there is statistically significant difference in the inclination distribution of wide-binary systems with transiting planets compared to a control sample, with the probability that the two distributions are the same being 0.0037. This implies that there is an overabundance of planets in binary systems whose orbits are aligned with those of the binary. The overabundance of aligned systems appears to primarily have semimajor axes less than 700 AU. We investigate some effects that could cause the alignment and conclude that a torque caused by a misaligned binary companion on the protoplanetary disk is the most promising explanation.

About

Variable Stars South is an international association of astronomers, mainly amateur, interested in researching the rich and under-explored myriad of southern variable stars.

Renamed from the Variable Star Section of the Royal Astronomical Society of New Zealand, it was founded in 1927 by the late Dr Frank Bateson, OBE, and became the recognised centre for Southern Hemisphere variable star research.

VSS covers many areas and techniques of variable star research, organised into projects such as Beginners' Visual Observations and Dual-Maxima Miras. The goal of each project is to obtain scientifically useful data and results. These may be published in recognised journals, or supplied to international specialist data collection organisations.

VSS is entirely an internet based organisation, working through our website http://www.VariableStarsSouth.org and its e-group http://groups.google.com/group/vss-members. It also encourages members to work in with major international organisations such as the British Astronomical Association, the Center for Backyard Astrophysics and the American Association for Variable Star Observers.

To find out more, please visit our website, where, incidentally, you will find PDF copies of all our newsletters. Our website has a great deal of information for VSS members, and for anyone interested in southern hemisphere variable star research. All VSS project information and data is kept here too.

Who's who

Director Mark Blackford

Treasurer/Membership Bob Evans

Newsletter Editor Phil Evans

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Visit our website to see a list of our area advisers, and to find out about our projects and how to contact their leaders

Membership

New members are welcome. There is no annual subscription but donations would be gratefully received. Find out how to join by visiting the VSS website. There you will find out how to join by post, email, or directly online. If you join by email or online and wish to make a donation you will get a link to pay by PayPal's secure online payment system, from your credit card or bank account.

After you've joined and received your membership certificate, you will be signed up to the VSS-members egroup (see above), and you will also receive a password to access the members' areas of our website.

Newsletter items

These are welcomed and should be sent to the Editor (phil@astrofizz.com). I'd prefer Microsoft Word (or compatible) files with graphics sent separately. Don't use elaborate formatting or fancy fonts and please do not send your contribution as a fully formatted PDF file.

Publication dates are January, April, July and October, nominally on the twentieth day of these months and the copy deadline is the thirteenth of the month though earlier would always be appreciated.

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