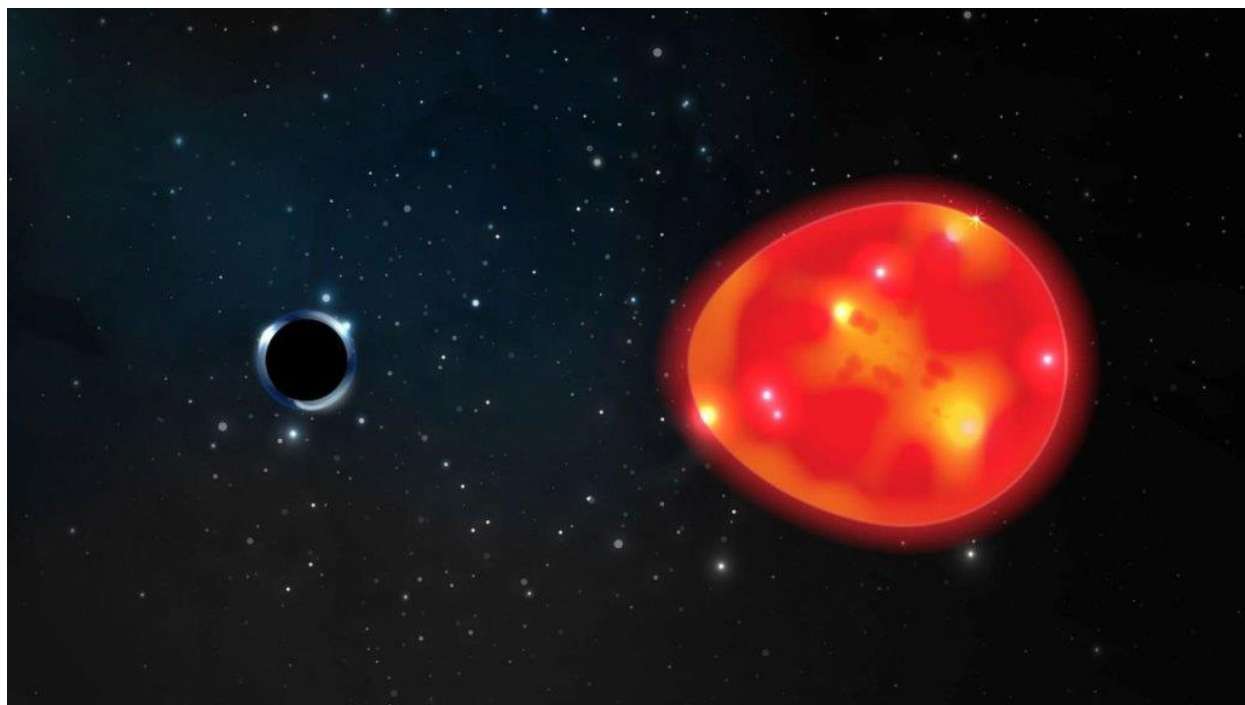




'Quiet Black Hole binary' --- envisaged as a possible model for the regular light variations of Algol by John Michell in 1767 (see the short review article on page 8). The image is credited to Lauren Fanfer, College of Arts and Sciences, Ohio State Univ.; see also L Kruesi, Science News 4/4/22.

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From the Director – Mark Blackford

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Welcome to our third and final edition of the Newsletter for 2025. The decision was made to skip the July edition due to our editor, Ed Budding, and I being away on extended overseas trips. Ed travelled to the Keele University in the UK for the Binary Stars In the Space Era conference where he gave a contribution on John Michell, celebrating 300 years since his pioneering studies on binary stars (see the review article on page 8). I, on the other hand, was simply holidaying in Europe and Africa.



Also in this issue, I conclude my assessment of methods to transform Tycho 2 photometry to Johnson-Cousins BVR for bright star photometry. Roy Axelsen writes about his observations and analysis of the High Amplitude δ Scuti star ZZ Microscopii, and Mati Morel clears up a decades old issue of the comparison sequence for NT Tel.

As always, we encourage contributions to the Newsletter from VSS members and other interested people. Please contact me or Ed Budding.

Congratulations to John Search on his discovery of not one, but two, novae within 24 hours. Nova Sagittarii 2025 No. 4 (V7994 Sagittarii) was found on images taken on Sept. 21.381 UT, and Nova Centauri 2025 No. 4 (V1935 Centauri) was recorded on images taken on Sept. 22.396 UT. Both are subjects of AAVSO Observing Campaigns.

The NACAA Secretariat, in collaboration with the Tamworth Regional Astronomical Club (TRAC), advise that NACAA 2026 will be held in Tamworth, NSW over the weekend of the 3rd - 5th April 2026 (<https://nacaa.org.au/2026>). I plan to attend and encourage other VSS members to consider doing the same.

Next year's RASNZ conference will be in Blenheim, 15th - 17th May.

There has not been a great deal of activity at Congarinni Observatory since the last Newsletter. I was away for nearly 2 months, and since returning in mid-August I've managed only a few nights of observing. The weather was mostly to blame, with a couple of weeks also lost to observatory maintenance. Binocular observations of the lunar eclipse in the early hours of September 8 was a highlight for me.

Wishing you all clear skies and good health,

Mark Blackford

Two suspected variables near NT Tel

Mati Morel, mmorel17@bigpond.org

Abstract

Previous reports of possible variations of two stars close to NT Tel on the sky are explained in terms of inconsistencies in the finder chart for NT Tel.

The issue

There is an issue with the comparison sequence for NT Tel, originally published for visual use in 1980, which apparently resulted in spurious observations. The issue has been resolved, and the spurious observations can be explained.

Andrews (1976) published a sequence of six comparison stars, from 12.03V to 15.27V, with a finder chart. Two of his comparison stars now have NSV names.

Name	Position (J2000)	V	B-V	Source	NSV
NT Tel-d	19 22 44.92 -50 26 36.4	12.35	+1.33	Andrews	24755 12.4 - (15.0)V
NT Tel-f	19 22 27.79 -50 25 09.9	12.05	+1.53	Andrews	24752 12.1 - (15.0)V

Andrews' chart was incorporated into VSS chart 560, published in 1980, as the central detail of a much larger field. Unfortunately, the detailed part turned out to be a "mirror image", and inconsistent with the surrounding field. Consequently, observers in the 1980s would have had trouble reconciling the chart with what was in the sky. All of the comparison stars were offset from NT Tel in the wrong direction, and by varying amounts, though users were not to know the reason. The observer would have looked for "d" at a spot about 2.5 arcmin westward of the true position and seen only a blank spot. Similarly, for "f"; it would have appeared to be offset about 9 arcmin, and the observer, looking at the plotted position would again have seen nothing. This explains why both "d" and "f" were both recorded at <15.0V.

So, the negative estimates for "d" and "f" were due to a faulty chart. This defect in the chart was corrected in 1992, with the issue of VSS charts 1055 and 1056. I have looked at both stars in the ASAS database, with the following results.

"d" : V = 12.323 (err 0.060) 505 obs "f" : V = 12.057 (0.057) 511 obs.

While both stars are rather red, and not the ideal pick for comparison stars, they appear to be pretty constant. The ASAS errors are consistent with stars of 12th mag.

I conclude that reports of large magnitude variations of NSV 24752 and NSV 24755 are almost certainly due to misidentification, from a faulty chart.

Reference

Andrews, P.J. 1976, *Mon. Not. R.A.S.* v174, p701

John Michell: a short tercentenary review

Ed Budding, VSS; & John Southworth, Astrophysics Group, Keele University, UK

Abstract

John Michell, the 'father of double star astronomy', was born just 300 years ago. His lifetime fits fairly centrally into the 18th Century enlightenment era period characterized by reason, liberality and scepticism. Although relatively little is known about this science pioneer, it is enough to make his reputation outstanding. The connection with binary stars starts with his statistical analysis, showing that some observed pairs of stars must be locally bound and not just optical pairs. But the 1767 paper includes that result as only part of a wider discussion with far-reaching implications on stellar systems and the means to observe them. Curiously, these ideas were largely overlooked for a long time. The best-known example is probably his dark star (1784) discussion – an early forerunner of the Black Hole concept.

1. Background

The following review was initially prepared for presentation at the 'Binary Stars in the Space Era' conference, held at Keele University, UK, in mid-2025. A few points relevant to the conference's circumstances were first recalled. While it is generally easy nowadays to find the main facts about a historical figure like John Michell, in his case the list seems relatively brief and, oddly, without any surviving portrait. This contrasts with, for example, our knowledge of Michell's near contemporary from the midlands -- Erasmus Darwin. The historical connections between the Darwins, and related persons, to Keele are well-known (Mountford, 1972), and are not pursued further here. Less well-known is that John Michell was a tutor of Erasmus during the latter's early days at Queen's College, Cambridge (McCormach, 2022).

John Michell was born into a clerical family home in Nottinghamshire just three hundred years ago. His lifetime fits fairly centrally into the 18th Century enlightenment era (Robertson, 2020) -- a period characterized by Newtonian-style reasoning and experiment, exemplified by the introduction and use of reflecting telescopes (King, 1955). But Michell's remarkable ideas appear to have been neglected for a long time, perhaps because they were so much in advance of contemporary science.

2. Double star science

Michell has been hailed as the 'father of double star astronomy' on the basis of his statistical analysis showing that some observed pairs of stars must be locally bound and not just optical pairs coincidentally close to the line of sight. But the paper in question (Michell, 1767) includes that topic as only part of a bigger discussion advocating the development of large reflecting telescopes to provide fuller evidence on stellar groupings and associations.

Michell's interest in experimental verification is clear from his development of the torsion balance, used first to check the field distribution near a magnetic pole, and later applied to determination of the gravitation constant G . His method and equipment were later passed on to his friend Henry Cavendish (McCormach, 2022), whose name has become much more well-known in this connection. Michell's (1759) paper on the propagation of seismic energy, using data from the disastrous Lisbon earthquake of 1755, later earned him the title 'father of seismology', which is also noteworthy in the context of astero-seismology.

Eye-catching, with regard to modern astrophysics, is Michell's early model for a 'dark star', as he called it. The Newtonian black hole obviously differs from present-day formulations, but perhaps there is a parallel in the invocation of such a model to provide a basis for physical discussion. For example, Michell suggested that the periodic light variation of Algol could be explained by a suitable arrangement of a dark and a more regular (sun-like) star. Rather than go into details about that, however, we select a few general, but relevant, thinking points from the literature.

3. Theory and observations

We are particularly assisted in this by McCormach's (2022) comprehensive biography. Zdeněk Kopal argued that no one can be proficient in both theory and practical science, although either type should at least be generally aware of what their colleagues are doing. This point carried less weight in the 18th century than in today's highly specialized pursuits. Michell, and his contemporaries, thought of themselves as *natural philosophers*. They followed the examples of Kepler, Galileo and Newton; but were unlike the ancients in requiring first-hand evidence to shore up theory.

Regarding visual double stars: at what point do nearest neighbours on the sky become more likely a common-orbit binary star? It is clear that a clustering of stars, like the Pleiades, does not follow the same distribution of nearest-neighbour separations as stars of the general field. Michell was careful to frame the separation likelihoods in quantitative terms. He could then confidently propose that there were stellar systems, comparable to the solar system, but on a different scale. From that, the same force that maintains the solar system is reasonably posited as that which holds in place stellar systems.



Fig 1: The Pleiades cluster in the sky field (credit: Pete Lawrence / BBC Sky at Night Magazine)

Michell knew that the number of stars seen in clusters like the Pleiades increases with the size of the telescope's objective: a fact with clear implications for stellar systems. This point caused him to design and start to build a 75 cm objective reflector that would have been the largest in the world at the time. The simplest example of a gravitationally bound stellar system is a double star-- like those observed in the telescopes of the Herschels. These catalogued doubles have relatively bright primaries and separations on the order of a few arcseconds or less. Michell showed that for basically sun-like pairs of stars such as these, the probability of physical close binarity is very high.

Aitken's (1932) formula, relating separation ρ and V magnitude to discriminate true physical binaries worthy of follow-up measurements from optical pairs ($\log \rho = 2.8 - 0.2V$) appears overly stringent in this respect (too low a constant). The gravitational field that holds visual binaries together was confirmed observationally by William Herschel (1803) in a famous paper on visual binaries.

Was Michell the first to make a realistic estimate of the distances of stars? Maybe not, but he was the first to consider photometric parallaxes in the context of bound physical systems. As McCormmach notes, after Michell, stellar astronomy had acquired *important new perspectives other than just giving reference points to check planetary motions*.

4. Change of scene

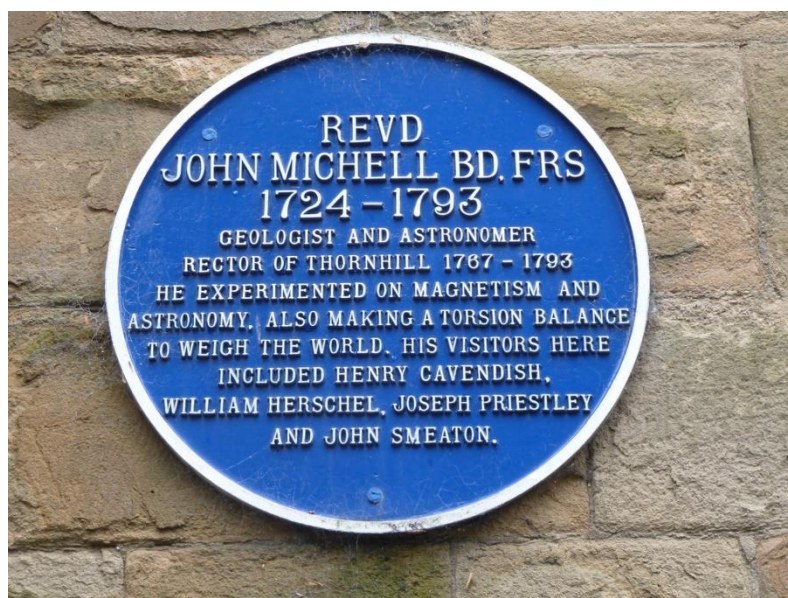


Fig 2: Memorial plaque at St Michael and all angels' church, Thornhill, near Wakefield, W. Yorkshire, UK, where John Michael was rector (1767-93).

After moving to Thornhill in 1767, Michell continued engaging with like-minded colleagues with the ample support of the Savilian estate. John Michell sometimes presented at the Royal Society Club, whose regular informal gatherings were held at the Cat and Bagpipes tavern on Downing St, Westminster. He was also a member of the Birmingham Lunar Society, where he met up with old friends from the Darwin family (McCormmach, 2022). Apart from the names on the blue plaque at Thornhill parish church, there were visits by other notables, including Benjamin Franklin, the American polymath and US founding father.

Before finishing, we would add something about the interaction with William Herschel. Herschel's taking up of astronomy was initiated with encouragement of a former student of Michell – the physician William Watson. So, Michell can be regarded as an 'academic grandfather' to Herschel. Herschel visited Michell at

least once, towards the end of the latter's life. He gave £30 for the unfinished 75 cm telescope. That would value at around £20000 in today's currency.

Regarding the 'dark star' concept that brought attention to Michell's work in recent years; true to his natural philosopher calling, Michell sought to check the hypothesis by observational evidence. He somehow hit on the idea that the expected shifts in the image of a light source deflected in a gravitational field might be detected using a prism. Herschel and Maskelyne tried to verify this suggestion but failed. Without general relativity, a wave theory, or the Doppler formula, it's difficult to see how 18th century science could have succeeded. However, Herschel's interest in prisms may well have been kindled as a result of this project, leading to his remarkable discovery of infra-red radiation at the end of that century (Herschel, 1800).

5. Conclusion

Although not usually regarded as within the core of mainstream scientific disciplines, of course, there must be a value to history. The subject has both protective and productive functions in preventing the repetition of misdeeds and guidance for future actions. Michell's biography indicates that ideas that may initially seem wild may require, in a research context, a spirit of tolerance, as they could become very important in due course.

References

- Aitken, R., 1932 *The New General Catalogue of Double Stars Within 120° of the North Pole*, Carnegie Institution of Washington. Publication No. 417
- Herschel, W., 1800, *Phil. Trans. R. Soc. London*, v90, p284
- Herschel, W., 1803, *Phil. Trans. R. Soc. London*, v93, p339
- King, H.C., 1955, *The History of the Telescope*. London: Charles Griffin & Co.
- Kopal, Z., 1986, *Of Stars and Men*, Adam Hilger, Bristol & Boston
- McCormmach, R., 2022, *Weighing the World*, Springer
- Michell, J., 1759, *Phil. Trans. R. Soc. London*, v51, p56
- Michell, J., 1767, *Phil. Trans. R. Soc. London*, v57, p234
- Michell, J., 1784, *Phil. Trans. R. Soc. London*, v74, p35
- Mountford, J., 1972, *Keele: An Historical Critique*. London: Routledge & Kegan Paul
- Robertson, R., 2020, *The Enlightenment: The Pursuit of Happiness, 1680-1790*, Allen Lane

Estimating $V - R$ and $V - I$ colour indices from B_T and V_T magnitudes from the Tycho-2 catalogue

Mark Blackford, Congarinni Observatory

In the previous edition of this Newsletter, I looked at methods of transforming Tycho-2 B_T and V_T magnitudes to the more commonly used Johnson-Cousins BVRI photometric system (Blackford, 2025). I concluded that the Mamajek, Meyer & Leibert (2002, 2006) equations produce transformed V and $B - V$ values in excellent agreement with the E Region standard star catalogue.

However, the linear equations used by the AAVSO Sequence team for transforming B_T and V_T to Johnson-Cousins $V - R$ and $V - I$ do not produce reasonable results. Polynomial relationships of Caldwell et al. (1993) do a better job (after first calculating $B - V$ from the B_T and V_T magnitudes) but is complicated by the need to know if a star is classified as a giant or dwarf.

In this article I explore using polynomial relationships to transform directly from B_T and V_T to Johnson-Cousins $V - R$ and $V - I$, without needing to know the dwarf/giant status of the star.

Test sample of bright standard stars

This study required a reasonably large test sample of stars with Tycho-2 magnitudes and accurately measured Johnson-Cousins magnitudes. This was compiled from catalogues of standard stars by Landolt (2007, 2009, 2013), Landolt & Uomoto (2007), and Menzies et al. (1989), accessed via the VizieR website at the Strasbourg Astronomical Data Center (<https://cds.unistra.fr/>). These catalogues contain accurately measured V magnitude and colour indices of ~1700 stars in the Johnson-Cousins UBVR photometric system. From these, a sample of 760 stars brighter than $V = 11.6$ were selected and the corresponding B_T and V_T magnitudes extracted from the Tycho-2 catalogue (also via VizieR).

Transformation plots

The top panels of Figure 1 show plots of the Johnson-Cousins $V - R$ colour index (y-axis) as a function of the Tycho-2 $B_T - V_T$ colour index (x-axis). All 760 stars in the test sample are plotted in the left panel (blue open circles). The red curve is a least-squares fit of an 8th order polynomial, and the red dots are the residuals (displaced by 0.5 mag). The right panel shows the same after rejecting outliers.

Plots of Johnson-Cousins $V - I$ colour index (y-axis) as a function of the Tycho-2 $B_T - V_T$ colour index (x-axis) are shown in the lower panels.

In the $V - R$ plot 49 stars were deemed to be outliers. Of these, 42 were also outliers in the $V - I$ plot plus an additional 8 stars. I did not look in detail at why these stars were outliers, however the SIMBAD database listed 6 of the rejected stars as variable. Excessive emission or absorption lines could account for other rejected stars.

Transformation equations

Polynomials of order 2 through 10 were tested and an 8th order polynomial was selected as the best fit over a wide range of $B_T - V_T$ values for both the $V - R$ and $V - I$ transformations. The equations are of the form:

$$Y = b + c1*X + c2*X^2 + c3*X^3 + c4*X^4 + c5*X^5 + c6*X^6 + c7*X^7 + c8*X^8 \quad (1)$$

Where $X = B_T - V_T$, $Y = V - R$ or $V - I$, and $c1$ to $c8$ are polynomial coefficients which are listed in Table 1. These are applicable for $B_T - V_T$ values from -0.3 to 2.0.

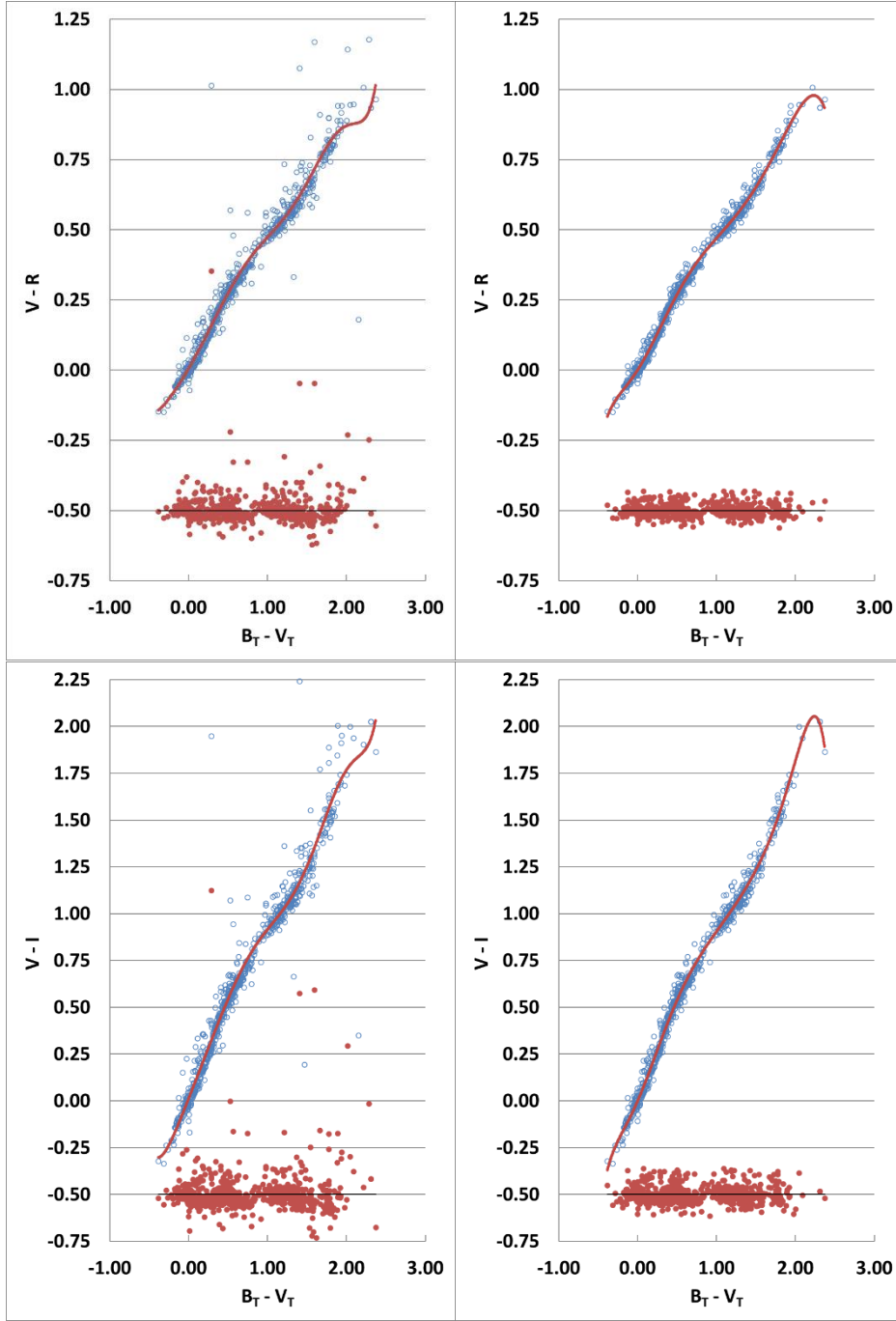


Figure 1: $V - R$ as a function of $B_T - V_T$ (top panels) and $V - I$ as a function of $B_T - V_T$ (bottom panels) for all 760 standard stars in the test sample (left), and after rejecting outliers (right). Residuals are shown as red dots; red line is an 8th order polynomial fit.

Table 1: Polynomial coefficients for transforming Tycho-2 $B_T - V_T$ to Johnson-Cousins $V - R$ and $V - I$.

	V - R coefs	V - I coefs
c8	-0.03485628	-0.14678625
c7	0.30827861	1.11155373
c6	-1.11204628	-3.32916693
c5	1.95888850	4.81082588
c4	-1.47422554	-2.87472413
c3	0.00872809	-0.29273610
c2	0.37365206	0.65950602
c1	0.44156817	0.96784742
b	0.00043417	-0.00116765

Assessment of transformation equation

To assess how well Equation 1 and the coefficients in Table 2 transform Tycho-2 magnitudes, I used the same test sample of 473 E Region standard stars as used in Blackford (2025).

The top left panel of Figure 2 shows the difference between transformed $V - R$ and the catalogue value plotted as a function of catalogue $V - R$ colour index. This is considerably better than the AAVSO transformation (Figure 2 middle left).

The top right panel of Figure 2 shows a similar plot for $V - I$ colour index. Again, this is considerably better than the AAVSO transformation (Figure 2 middle right).

However, the Caldwell et al. (1993) transformation procedure produce less scatter in the residuals of both the $V - R$ (Figure 2 bottom left) and $V - I$ (Figure 2 bottom right) colour indices.

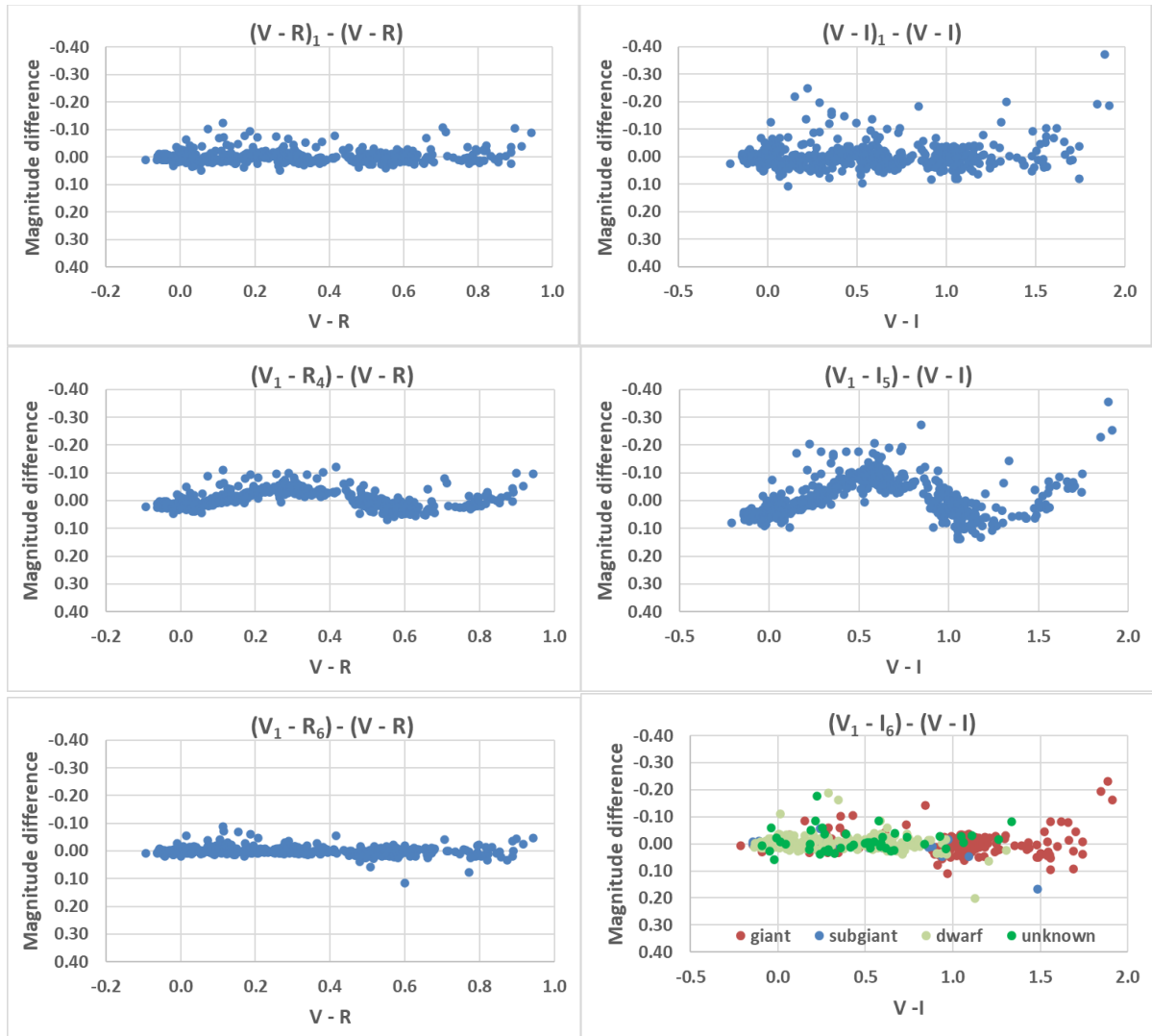


Figure 2: Difference between calculated and catalogue colour index for $V - R$ (left) and $V - I$ (right). 8th order polynomial (top row); AAVSO Sequence Team linear transformation equation (middle row); Caldwell et al. (1993) relationships (bottom row). Plots in middle and bottom rows are from Blackford (2025).

Conclusions

This study confirms that transformation of Tycho-2 magnitudes to Johnson-Cousins $V - R$ and $V - I$ colour indices using an 8th order polynomial produces better results than the simple linear equations. However, the Caldwell et al. (1993) relationships, with the correction noted in Blackford (2025), are better still.

Comparison stars with known magnitudes are recommended for differential photometry, but these are not always available.

For stars brighter than ~ 11.5 V mag the Tycho-2 catalogue provides many potential comparison stars. However, the Tycho-2 V_T and B_T filters are not precisely matched to the corresponding V and B filters in the standard Johnson-Cousins system, and there were no filters covering the R and I passbands.

The equations of Mamajek, Meyer & Leibert (2002, 2006) are recommended for transforming B_T and V_T magnitudes to V and $B - V$ values.

Polynomial relationships 2 and 4 of Caldwell et al. (1993) can then be used to calculate $V - R$ and $V - I$ values, respectively. However, for dwarf stars the “shfy” parameter for relationship 4 must be set to 1.175 instead of 1, as listed in their paper. The downside of this method is that we need to know whether a potential comparison star is classified as a giant or dwarf, so the correct transformation coefficients are used.

Acknowledgements

This research made use of the NASA Astrophysics Data System Bibliographic Services and the VizieR catalogue access tool, CDS, Strasbourg, France (DOI: 10.26093/cds/vizieR). The original description of the VizieR service was published in 2000, A&AS 143, 23.

References

- Blackford, M. G. 2025, VSS NL 2025-1
- Caldwell J. A. R., Cousins A. W. J., Ahlers C. C., van Wamelen P., Maritz E. J., 1993, S. African Astro. Obs. Circular, No. 15:1
- Landolt, A. U. 2007, AJ, 133, 2502
- Landolt, A. U. 2009, AJ, 137, 4186
- Landolt, A. U. 2013, AJ, 146, 131
- Landolt A.U., Uomoto A.K. 2007, 133, 768
- Menzies, J.W., *et al.* S. African Astro. Obs. Circular, No. 13:113, 1989

Analysis of Period Change in the High Amplitude δ Scuti Star ZZ Microscopii

Roy Axelsen, VSS

Abstract

Times of peaks in the light curve of ZZ Mic obtained from literature, public access databases and personal observations are analysed. The O-C diagram is reinterpreted, and an ephemeris valid for September 2024 calculated.

1. Introduction

ZZ Mic is a High Amplitude δ Scuti Star (HADS) with a period of 0.06717915 d, or about 96.7 m. The amplitude corresponds to a light variation from about 9.27 to 9.59 V (Variable Star Index of the AAVSO, accessed 7 October 2025).

The variability of ZZ Mic was first reported by Churms and Evans (1961). Percy (1976) analysed data by Leung (1968) and reported two periods of 0.0654 d and 0.0513 d. Deras (2009) found the second period to have a much smaller amplitude than that of the principal period. Kim and Moon (2009) analysed data from 1960 to 2003 and found that the period was increasing at a constant rate. Axelsen and Napier-Munn (2015) added personal photoelectric photometric data from 2008 and DSLR photometric data from 2014. They fitted a third order polynomial expression to the O-C diagram, which supported Kim and Moon's (2009) conclusion, from earlier data, that the period was increasing, but suggested that the period had changed and was subsequently decreasing at a constant rate.

This paper reports period analysis of a substantially expanded dataset to September 2024, and a re-interpretation of the O-C diagram.

2. Sources of Data

Times of maximum derived from the literature were published by Churms and Evans (1961), Leung (1968), Chambliss (1971), Balona and Martin (1978), Kim and Moon (2009) and Axelsen and Napier-Munn (2015). Data from the AAVSO International Database, submitted by AAVSO observers BIW, DSI and RIX, were used to calculate times of maximum from 2005 to 2008. A few times of maximum were determined from TESS (Transiting Exoplanet Survey Satellite) data from 2018 to 2023. Finally, the author's observations by photoelectric photometry using a Johnson V filter, DSLR photometry, and photometry using a monochrome CMOS astronomical camera imaging through a Johnson V filter, are brought together here.

3. Methods

Epochs and times of maximum from the various quoted sources in the literature were transcribed and plotted in O-C diagrams displayed below. Times of maximum from the AAVSO International Database, TESS data and the author's photometry were calculated by finding the time of the maximum value of a 7th order polynomial expression fitted to each of the peaks of the light curve chosen for measurement. The Date-Compensated Discrete Fourier Transform in VStar (Benn, 2012) was employed to display principal and secondary frequencies of pulsation for TESS data from July and August 2018 (Mikulski Archive for Space Telescopes (MAST) Portal at <https://mast.stsci.edu/portal/Mashup/Clients/Mast/Portal.html>). Microsoft Excel was used for regression analysis.

4. Results

Fourier analysis of data from TESS reveals two pulsation frequencies, 14.88724 c/d and 18.22744 c/d, the latter frequency having a much lower semi-amplitude than the principal frequency (Fig. 1).

The question arises, will the existence of two pulsation frequencies impact on analysis of the period of ZZ Mic by the use of an O-C diagram? The clean phase plot of a TESS light curve of ZZ Mic shown in Fig. 2, and based on a single period of 0.06717915 d, implies that the answer to this question is in the negative. An example of a light curve obtained from personal observations, taken over 5hr 43min during one night in September 2024, is shown in Fig. 3.

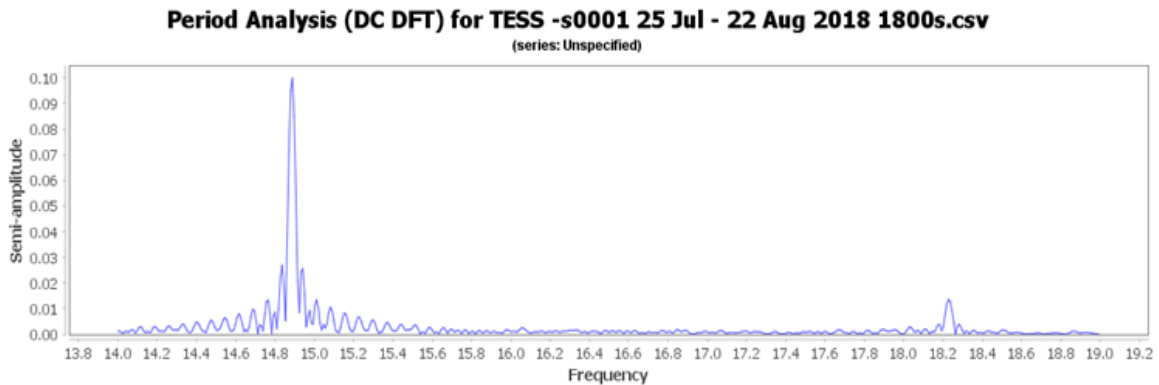


Fig. 1. Fourier analysis of TESS data showing a principal frequency of 88724 c/d and second frequency of 18.22744 c/d with a much lower semi-amplitude.

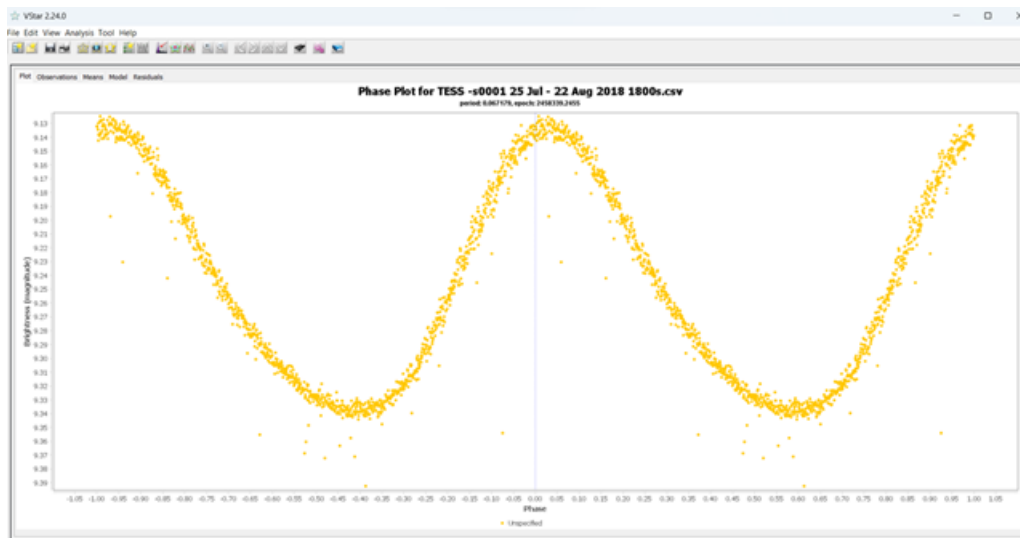


Fig 2. Phase plot of the light curve of ZZ Mic from TESS data, based on period 0.06717915 d.

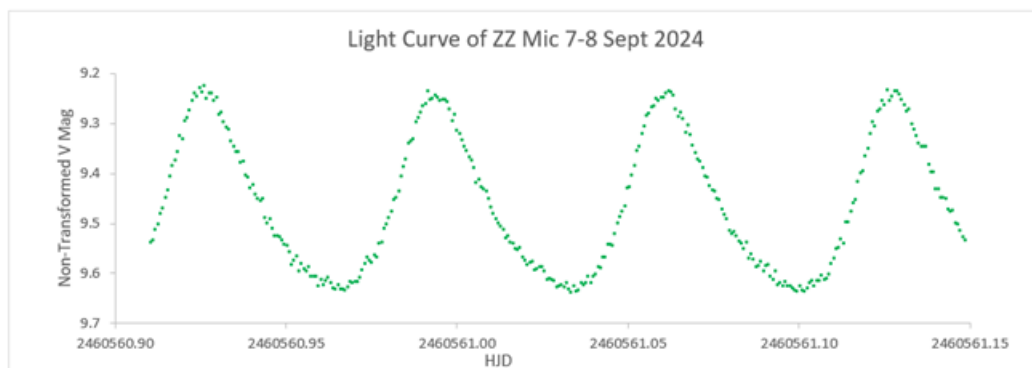


Fig. 3. Light curve of ZZ Mic taken over 5h 43min during one night in September 2024 using a monochrome CMOS camera imaging through a V filter and a 200mm f/2.8 camera lens.

Fig. 4 is a reproduction of the O-C diagram published by Kim and Moon (2009), showing a fitted parabola from a second order polynomial expression. The fit is concave up, evidencing an increase in the period of ZZ Mic at a constant rate.

Fig. 5 is a reproduction of an illustration from the paper by Axelsen and Napier-Munn (2015), showing the fitting of a third order polynomial expression to O-C data from the literature and personal PEP and DSLR photometric observations from 1960 to 2014. Much of the O-C diagram reproduces the published data of Kim and Moon (2009), which shows an increasing period, but the latter part indicates a change in the behaviour of the star with the period decreasing at a constant rate.

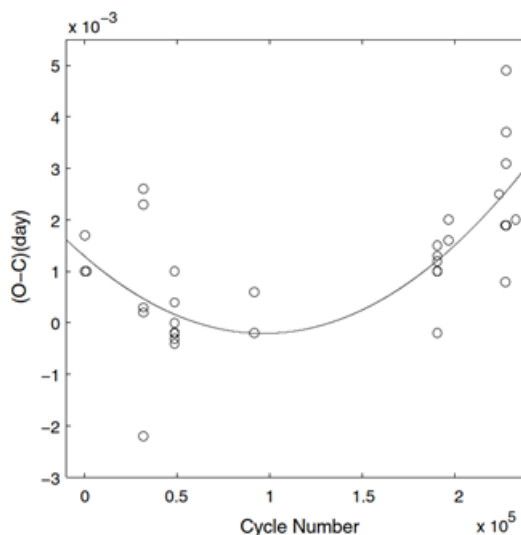


Fig. 4. This figure reproduces Figure 3 of Kim and Moon (2009) showing an O-C diagram with evidence of a period increase at a constant rate.

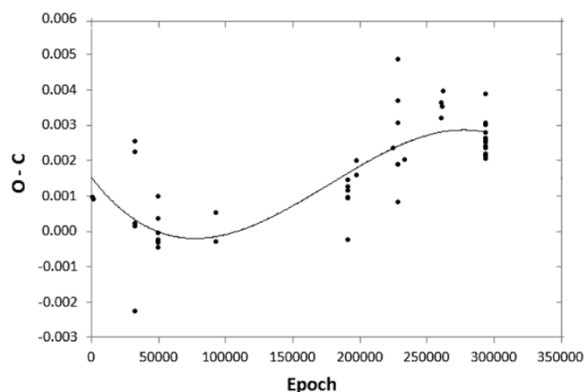


Fig. 5. This is a reproduction of the O-C diagram from Axelsen and Napier-Munn (2015) showing the fitting of a third order polynomial function to the O-C data from 1960 to 2014.

Analysis of the peak times of ZZ Mic light curve data to September 2024 includes published data referred to above, data from the AAVSO and TESS and personal observations made between 2008 and 2024. All of these are plotted in an O-C diagram shown in Fig. 6. This view provides a visual impression of two subsets of data: that to the left from 1960 to 1977 and the subset to the right representing data from 1995 to 2024. A linear function was fitted in Microsoft Excel to the earlier data to 1977, which revealed no trend, as the fit is a horizontal line. A second order polynomial function fitted the later data from 1995 to 2024 (Figure 7).

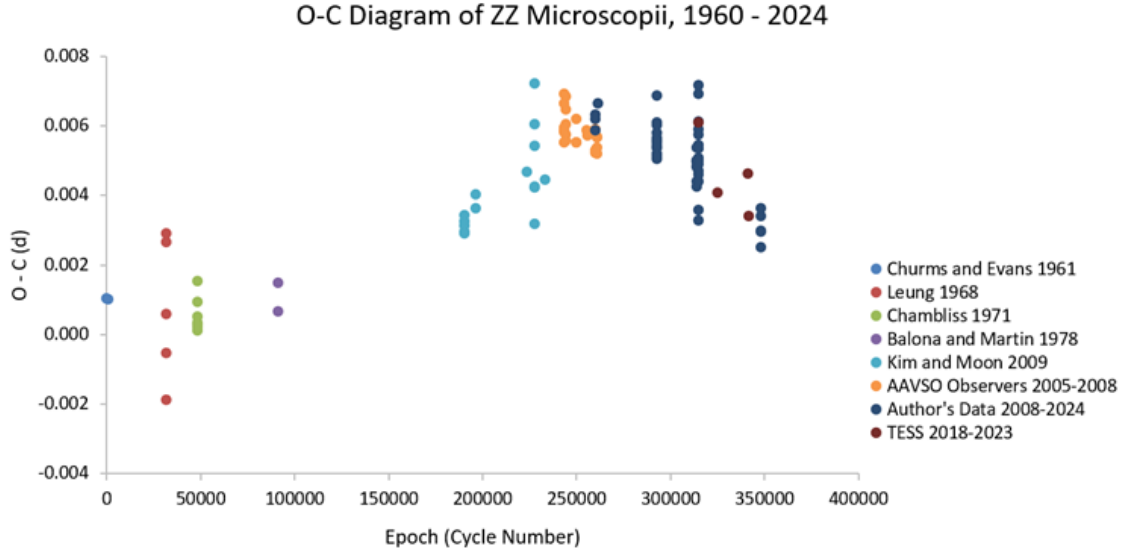


Fig. 6. O-C diagram of ZZ Mic from 1960 – 2024 showing the sources of the colour-coded data.

As the linear fit to the earlier data is a horizontal line (Figure 8) the period chosen for the calculation of the O-C values (the period in the AAVSO's Variable Star Index) is an accurate period. If the linear fit does, in fact, represent the true behaviour of the star, the period would have remained constant during the years over which the observations were taken.

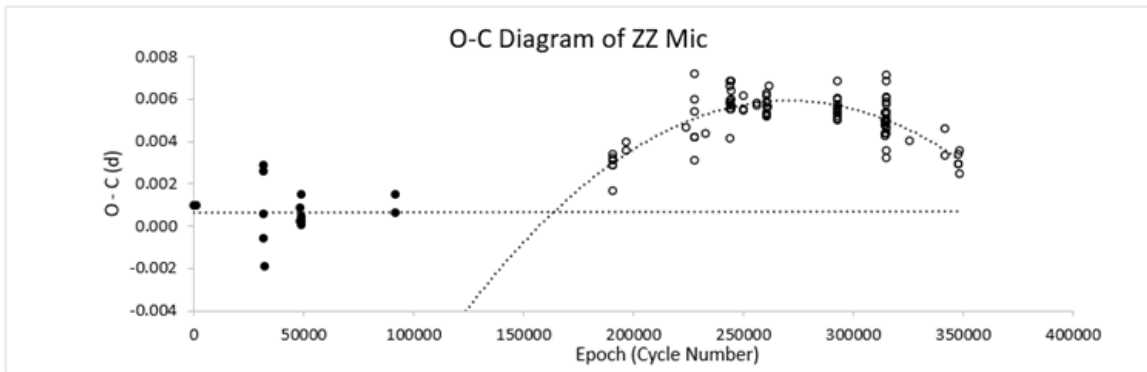


Fig. 7. O-C B&W 1960 – 2024, with linear and 2nd order fits.

Regression analysis using a second order polynomial function fitted to the data from 1995 to 2024 (Fig 9) reveals that the fit is highly significant for all three coefficients ($P < 0.0001$). The formula is given below in Eqn 1 in which the numbers in brackets represent the standard errors of the coefficients.

$$O-C = -4.5 (0.4) \times 10^{-13} E^2 + 2.4 (0.2) \times 10^{-8} E - 0.027 (0.002) \quad (1)$$

An ephemeris can be calculated for the data from 1995 to 2024 by plotting the times of maximum against the epochs. The plot is essentially a straight line (Fig 10) and a good ephemeris can, in fact, be obtained from the linear function that describes it. However, since the O-C diagram is clearly represented by a parabolic function, a similar function can be applied to the ephemeris plot. The coefficient of the first order term is the slope at zero epoch, which represents the period (0.067179415 d) at that time. However, zero epoch here is 1960. If the axis representing the epochs

is re-scaled so that the most recent time of maximum in September 2024 is at zero epoch, the values change to those shown in Eqn 2.

$$\text{TOM} = -4.5 (0.4) \times 10^{-13} E^2 + 0.067179100 (7) E + 2460561.1279 (3) \quad (2)$$

Thus, the period in September 2024 was 0.067179100 (7) d at epoch HJD 2460561.1279 (3).

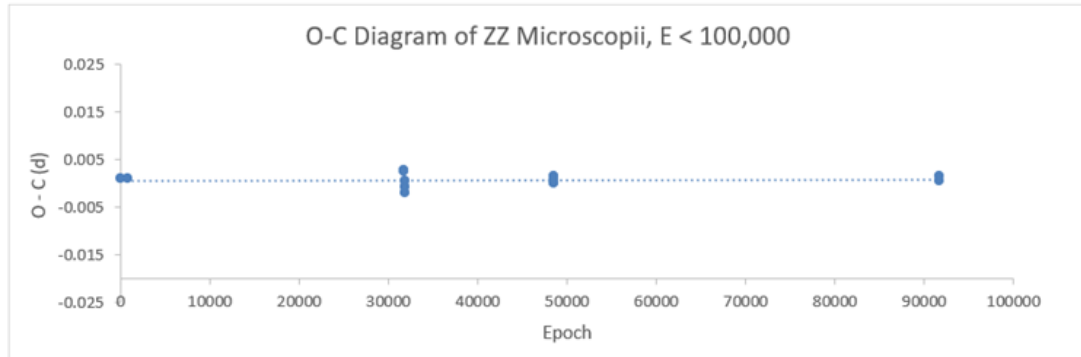


Fig. 8. O-C 1960 – 1977 with expanded y axis to show linear pattern, and in the text the formula without errors, to show almost zero slope.

Summary

An O-C diagram of the high amplitude δ Scuti star ZZ Mic was interpreted in 2009 as evidence that the period was increasing at a constant rate. Further studies published in 2015 suggested that the properties of the star had changed, with the period at that point decreasing at a constant rate.

However, analysis of the previous data, additional personal observations and those from public access databases to September 2024, are herein interpreted as evidence that the period of ZZ Mic was constant from 1960 to 1977 and that from 1995 to 2024 the period has been decreasing at a constant rate. The period in September 2024 is calculated to be 0.067179100 (7) d at epoch HJD 2460561.1279 (3).

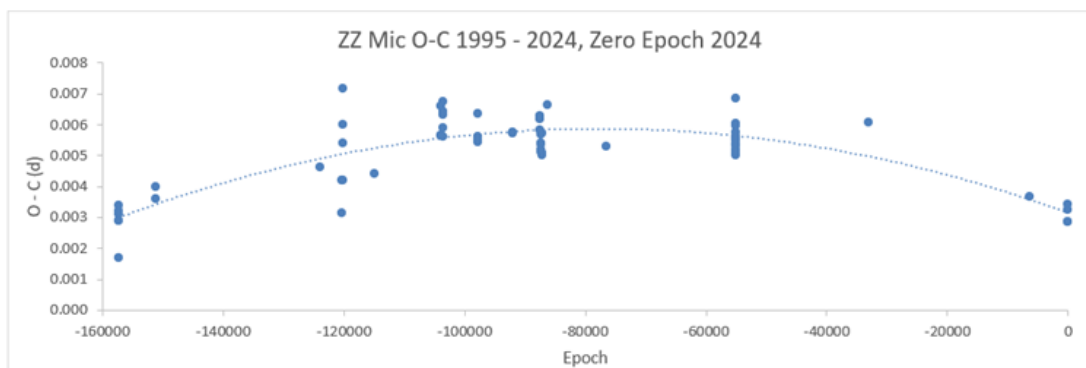


Fig. 9. O-C 1995 – 2024 with zero epoch shifted to 2024, with 2nd order equation in the text, to show squared term (for rate of period change calculation) and errors.

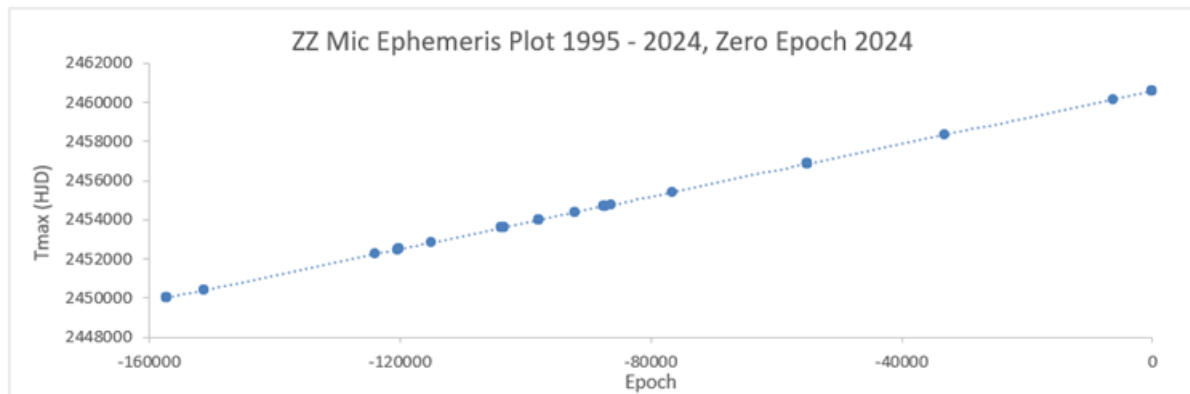


Fig. 10. $T_{\max}$ versus epoch 1995 – 2024, described by the equation

$$ToM = -0.000000000 E^2 + 0.067179100 (7) E + 2460561.1279 (3)$$

Bibliography

- Axelsen, R.A., and Napier-Munn, T. 2015, *J. Amer. Assoc. Var. Star Obs.*, **43**, 50.
 Benn, D. 2012. *J. Amer. Assoc. Var. Star Obs.*, **40**, 852.
 Balona, L.A., and Martin, W.L. 1978, *Mon. Not. Roy. Astron. Soc.*, **184**, 11.
 Chamblis, C.R. 1971, *Astrophys. J.*, **165**, 365.
 Churms, J., and Evans, D.S. 1961, *Observatory*, **81**, 25.
 Derekas, A., et al. 2009, *Mon. Not. Roy. Astron. Soc.*, **394**, 995.
 Kim, C., and Moon, B.-K. 2009. *Publ. Astron. Soc. Pacific*, **121**, 478.
 Leung, K.-C. 1968, *Astron. J.*, **73**, 500.
 Percy, J.R. 1976 (quoted by Kim and Moon, 2009), in *Proc. Solar and Stellar Pulsation Conf.*, Los Alamos Scientific Laboratory. Eds. Cox, A.N. and Dupree, R.G., Los Alamo Scientific Laboratory, NM, 61.

Absolute Parameters of Young Stars: NO Puppis

Erdem, Ahmet; Bakış, Volkan; Southworth, John; Rhodes, Michael D.; Kahraman Aliçavuş, Filiz; Budding, Edwin; Blackford, Mark; Banks, Timothy; Alexander, Murray

Abstract

The southern early-type, young, eccentric-orbit eclipsing binary NO Puppis forms the A component of the multiple star Gaia DR3 552\–8147999779517568. The B component is an astrometric binary now at a separation of about 8.1 arcsec. There may be other fainter stars in this interesting but complex stellar system. We have combined several lines of evidence, including TESS data from 4 sectors, new ground-based BVR photometry, HARPS (ESO) and HERCULES (UCMJO) high-resolution spectra and astrometry of NO Pup. We derive a revised set of absolute parameters with increased precision. Alternative optimal curve-fitting programs were used in the analysis, allowing a wider view of modelling and parameter uncertainties. The main parameters are as follows: $M_{Aa} = 3.58 \pm 0.11$, $M_{Ab} = 1.68 \pm 0.09$ ($M_{\odot}$); $R_{Aa} = 2.17 \pm 0.03$, $R_{Ab} = 1.51 \pm 0.06$ ($R_{\odot}$), and $T_{\text{eff}} Aa = 13300 \pm 500$, $T_{\text{eff}} Ab = 7400 \pm 500$ (K). We estimate approximate masses of the wide companions, Ba and Bb, as $M_{Ba} = 2.0$ and $M_{Bb} = 1.8$ ($M_{\odot}$). The close binary's orbital separation is $a = 8.51 \pm 0.05$ ($R_{\odot}$); its age is approximately 20 Myr and distance 172 ± 1 pc. The close binary's secondary (Ab) appears to be the source of low amplitude δ Scuti-type oscillations, although the form of these oscillations is irregular and un-repetitive. Analysis of the λ 6678 He I profile of the primary show synchronism of the mean bodily and orbital rotations. The retention of significant orbital eccentricity, despite the closeness of the Aab components, is unexpected and poses challenges for the explanation that we discuss.

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E-Print Comments: 22 pages, 21 figures, 13 tables, accepted for publication in PASA; doi:10.1017/pasa.2025.10080

Estimating orbital parameters for visual double stars

Vanukuri, A. ; Banks, T. S. ; Budding, E. ; Rhodes, M. D. ; Ersteniuk, M.

Abstract

A Bayesian optimisation technique was applied to estimate orbital parameters for the visual double stars Sirius, alpha Cen, AGC11AB, BU151AB, BU513AB, BU648, BU883AB, STT38BC, and STF1196AB. These estimates were compared with those adopted by the Washington Double Star catalog, showing good agreement. This indicates the reliability of the method, ahead of its planned use for systems with no prior published orbital parameter estimates.

Publication: Open European Journal on Variable stars, Vol. 259, p. 1-12.

Pub Date: January 2025 DOI: 10.5817/OEJV2025-0259

Binary Stars in the Space Era

Held at Keele University, UK, July, 2025

The book of abstracts for this conference is now available from the following webpage

https://www.astro.keele.ac.uk/jkt/keelebinaries2025/AbstractBooklet_final.pdf

Followers of current research in this field will find many topics of interest summarized in this source.

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 with major international organisations such as the British Astronomical Association, the Center for Backyard Astrophysics, and the American Association for Variable Star Observers.

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