



She's only three but already she can spot Jupiter. Stephen Hovell's grand-daughter Phoebe checks out the finder scope on his new 28" Dobsonian. See Stephen's article on page 19

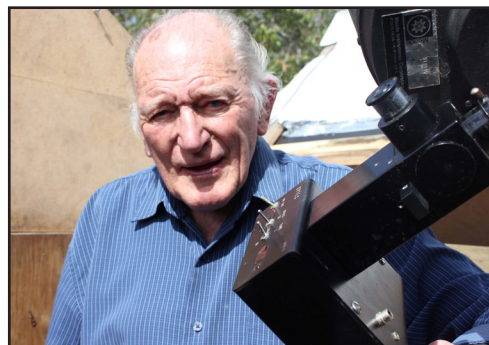
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From the directors - *Stan Walker & Mark Blackford*

From Stan...

In the previous Newsletter I mentioned that for personal reasons I would like to retire from this position earlier than at the end of 2017. So it was very welcome that Mark Blackford, who has been acting as an understudy in many ways, offered to take over this role after his tour of Canada. Mark will fill this position well and being a couple of decades younger will bring more energy and enthusiasm than I have these days.



Our director is appointed by the parent body, the RASNZ, and following approval of the change by our own management group it had to be approved by their council. This is the first time that any section director has been from outside New Zealand - Tom Richards moved to Australia from Auckland in the 1970s so was regarded differently - but Mark's ideas for the future of Variable Stars South and his astronomical experience were well presented and council was strongly in favour of this appointment. So these comments are from both the old and the new directors. But first some astronomy.

Sebastian Otero drew attention to a new dual maximum Mira in Circinis which prompted Andrew Pearce to examine a range of other stars as measured by ASAS3 and come up with some more possibilities. I also knew of a few others in the northern hemisphere and these have been included in the list of targets. Some of the northern people look at these as well. These seem related to Mira stars which show humps in the light curves so there are a couple of articles covering these.

We also now have a hemisphere-wide group measuring QZ Carinae. Alain Maury is observing from Chile where both the first part of ingress and the last of egress are measurable. Thus with Dave Blane in South Africa, Greg Bolt in Perth, Mark Blackford midway between Sydney and Brisbane, Simon Lowther in Auckland and a few others we should get a much clearer picture of the light curve than previously. At this stage poor weather has been a problem - 15 consecutive days with rain in NZ - and we need more measures of the early ingress from NZ. We'll probably extend the project next season to cover a few gaps.

All of this suggests that the well-equipped amateur photometrist needs a smaller telescope to handle the brighter objects or even the fainter Miras in R and I. So maybe a 75mm to hang on the side of the main unit or a completely separate set up with a C90 or Meade 103mm. This will enable measures of some of the hot, massive stars which are coming into prominence in photometric circles. I see VV Cephei mentioned in one of the AAVSO's forums.

David Moriarty has managed to get some out-of-eclipse spectra of V777 Sagittarii and once these are analysed this project can be completed. This project revealed some interesting aspects of DSLR photometry and also the problems with different sequences. These are discussed in the context of colour measures of Miras in two articles elsewhere.

My nearest astronomical neighbour, Stephen Hovell, has been enjoying visual observing with his latest acquisition, a 28" automated Dobsonian located in the Victoria Valley, about 8km south of Kaitia. It's a far cry from the 6" home-made telescope on a post in the back yard that many of us started with. I've been meaning to get down to Papatia but this winter is far too wet, windy and changeable. Spring must come soon!

Also in the near future is another eclipse of BL Telescopii - 778.6 days seems to be passing quite quickly. Looking at the measures over the last 2000 days there is a reasonable coverage but not consistently enough to deduce much. Apart from the main eclipses the GCVS quotes a secondary eclipse but no indication as to its phase, also a sometimes present 65.1 day pulsation. Measures of the out-of-eclipse features are probably best in V and B where the SR star variations seem to have the greatest amplitude.

So when you read this I will have handed over the direction of Variable Stars South to Mark Blackford. I'm unsure what direction I've given but it's been enjoyable, particularly at conferences where we can

meet and talk together. Next year's RASNZ Conference is at Christchurch which is rather more accessible than some of their more recent venues. Let's hope the earthquakes have run their course for a while.

Mark and I have discussed briefly the possibility of a symposium following next year's RASNZ event, much the same as in Whakatane a few years ago. Sunday evening and Monday. The timing will always clash with other meetings but this venue may attract some of the New Zealanders where our support is not as strong as we would wish - and Christchurch has direct flights from the large east Australian cities. Even if you cannot make one of these meetings, wherever it is, why not think of a poster paper?

Now I'm faced with the problem of which CCD camera to purchase and relearning colour photometry with an entirely different detector and rather different observing and reduction methods. So Mark, over to you and I trust you will enjoy it as much as I have.

...from Mark

Thanks Stan for an outstanding job of directing Variable Stars South over the last few years. Thanks also for the mentoring you've provided to me since 2010 when I join VSS as a complete novice struggling to master the intricacies of photometry using DSLR cameras.

Stan and Tom Richards, our first director, have built VSS into a strong, vibrant and respected variable star society which I hope to build even further with the help of our membership. My variable star experience is limited in years and breadth compared with Stan and Tom but as a group we have an enviable history.



My vision for Variable Stars South for the foreseeable future is to maintain our current structure and operations as they have worked well to this point. I will maintain the Management Committee structure set up by Stan Walker to share the administrative load and canvas ideas before bringing them to the general membership. I intend to work closely with project leaders to ensure the website, newsletter and symposia are properly supported as they are vital to the continued development of VSS. I would like to see more use of the Variable Stars South Google Group and Southern Eclipsing Binaries Google Group by members.

The project based structure within four broad research areas (Intrinsic Variables, Eclipsing Binaries, Pulsating Variables and Eruptive Variables), as initiated by Tom Richards, has served us well so I see no reason to change that structure. However, I would like to explore options for more Pro-Am collaborations within these research areas.

There is incredible potential for advanced amateurs to conduct exoplanet research in collaboration with professional space and ground based surveys. I hope to establish an Exoplanet research area to promote communication and cooperation between those members already working in this field and to encourage others to try their hand at exoplanet observing.

I participated in the RASNZ Conference and VSS Symposium in Whakatane as well as the Mt John Anniversary meeting and RASNZ Conference in Lake Tekapo. At these meetings I talked with many amateur and professional astronomers. I would like to use these contacts to expand the interaction of VSS members with professional astronomers with research interests in variable stars.

Finally, I would like to see regular VSS symposia as they allow members to meet face to face to exchange ideas and present their work. Stan Walker has made preliminary enquiries into holding our fifth symposium in conjunction with the RASNZ 2018 Conference in Christchurch. This is an easily accessible venue for observers from around New Zealand and internationally.

Finally, for those following my observatory building project in recent newsletters I will conclude the series in the next issue.

Abstract

A cleaner lightcurve is presented for the SR variable NGC 288-V1, based on ASAS data from HJD 2451869 to 2455166. The interval between successive minima is of the order of 317d.5 (mean), with large variations.

Introduction

NGC 288-V1 is a SR variable located in the northwestern fringe of this southern globular cluster. The location hopefully minimizes the effect of background stars on ASAS observations. An introduction to this variable was published by Morel (2017). In a follow-up a more detailed analysis of the data has been conducted, and a cleaner lightcurve prepared, corrected for the effect of star b, 10" south.

Method

The complete data list (table V_Mag_1, 672 observations) of ASAS 005241-2633.5, a blend of V1 + b, was downloaded. From this means were computed for each 10-day interval, limited to data within the band 11.5 - 12.5V. This furnished 188 means. Each value was then individually corrected for the effect ($\sim 0.20\text{mag}$) of star b. The lightcurve has been plotted by computer, and the size of each dot scaled according to the number of observations in each 10-day mean. It is expected that means with one or two observations (smallest dot) have the lowest weight, while the largest dot, with 6 or more observations have the highest weight. For clarity, the continuous lightcurve has been broken into three segments - A, B and C. See Fig. 1. The faint limit is 12.6V, as any value below this is likely to be contaminated by the background.

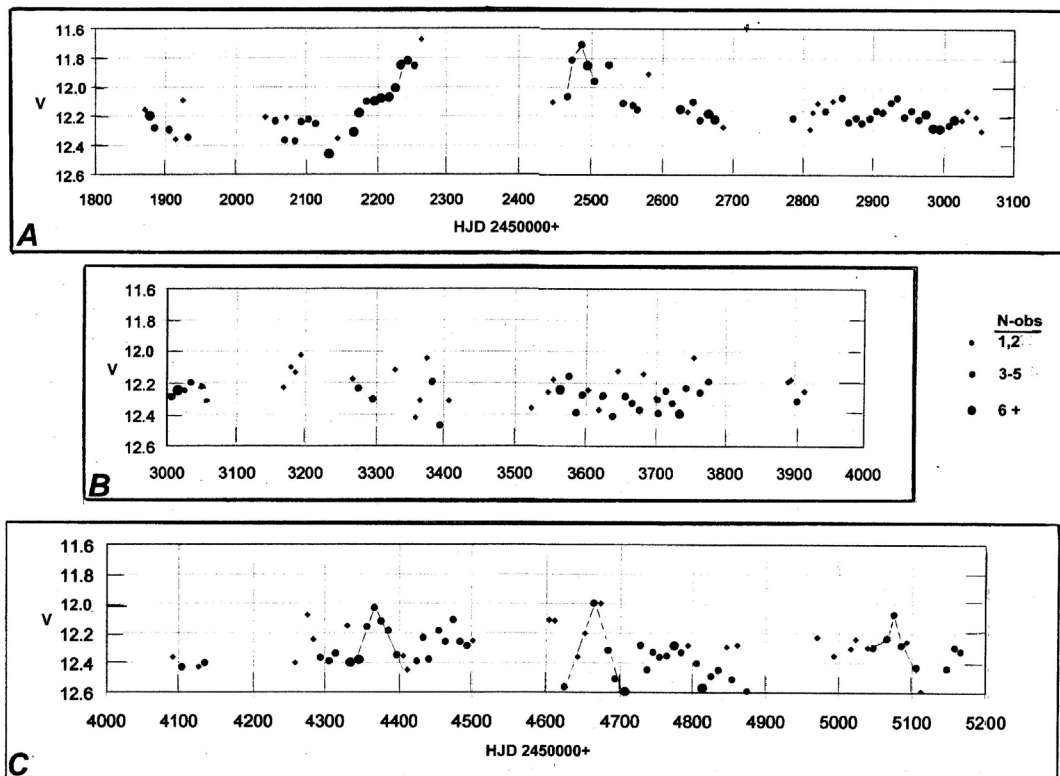


Fig. 1. - A, -B and -C. Lightcurve of NGC288-V1, corrected. 10-day means. Two distinct peaks in A, three in C.

Discussion

From my lightcurve I have identified five major peaks. My criteria for major peaks are:

- steep rise and fall
- exceeds $V = 12.1$
- sharp maximum based on 3 to 5 observations, in a 10-day mean.

Major peaks are thus identified, and the intervening time. All are mean values.

HJD	Max.	Δ	
2450000 +	V	days	
2243.89	11.83	242.2	Well observed rise, $\sim 110^d$. Fall not observed.
2486.04	11.71		Short rise and fall. Rise $\sim 20^d$.
4365.76	12.03	299.8	
4665.54	12.00	410.6	Cycled from min $\rightarrow$ max $\rightarrow$ min in 80^d .
5076.11	12.07		

Mean: 317.5

Most maxima are followed by irregular fluctuations rarely exceeding $V=12.2$. There is no plausible argument for a short period of 103d (Oosterhoff 1943). He observed only three maxima, thus :

max	Δ
2425576	309 ^d
2425585	407
2426292	

He observed three minima as well, with intervals of 302d and 111d. Oosterhoff must have made some heroic assumptions about missed maxima, in order to derive a period as short as 103d. My lightcurve provides no support for such a period, at least for major peaks. There may be one or two minor peaks buried in the noise between the major ones but they are too difficult to discern, if they exist. My estimate for a period, expressed as mean interval (in days) between major peaks is

317.5	5 maxima, using ASAS data	OR
333.7	7 maxima, combining ASAS and Oosterhoff.	

ASAS intervals vary considerably, from 242.2 to 410.6. The extreme magnitude range for V1 is 11.7 to 12.6V.

Overall Mean Magnitudes.

672 individual ASAS observations	: 12.031V	Std. Deviation = 0.183
188 10-day means	: 12.036V	Std. Deviation = 0.138

Conclusion

I find, based on a corrected ASAS lightcurve, and 10-day means, that the major peaks for V1 occur at a mean interval of 317d.5. The extreme range in V is 11.7 to 12.6, but otherwise its maxima, and its irregular fluctuations do not exceed $V = 12.0$. I find no support for the published period of 103d.

References

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 Morel, M. 2017 VSS Newsletter 2017-2 (2017April) p3
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 Pojmanski, G. 1997 Acta Astronomica 47,467 [The All Sky Automated Survey]
 Pojmanski, G. 2002 Acta Astronomica 52,397 [ASAS data]

Introduction

The change in the light curve of BH Crucis from a dual maxima Mira to a single maximum star of that type indicates clearly that these two different types of light curve are related. The graph on the left of Figure 1 shows the mean V light curve as it was in the 1970s in blue, with a mean light curve from the early 2000s superimposed in red. Between these two dates the period also changed from ~421 days to ~520 days. Whether these two events are linked is not clear.

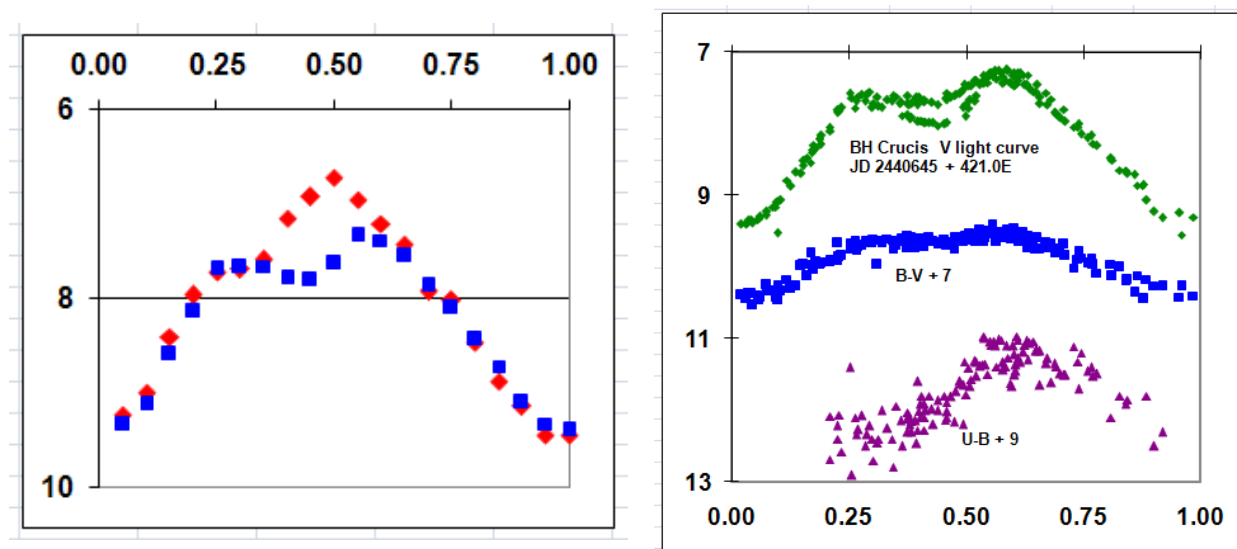


Figure 1 (left). Phased light curve of BH Crucis in V from 1970s (blue) and 2000s (red) showing its evolution from dual maxima to single maximum. Right - phased light curve in V compared with B-V and U-B colours.

On the right is shown a light curve in V with B-V and U-B colours also plotted. The B-V curve appears normal, brightest at the peaks of the two maxima. Its amplitude is unusually large but this might be typical for these low amplitude carbon Miras. The U-B light curve is a little noisy due to the faintness through the U filter but shows a very strong peak at the second maximum which the later evolution suggests is the main maximum.

The emphasis now with colour photometry of Miras is on BVRI measures but the measurement of a useful U signal is still possible with some of the CCD detectors with good U and B response. Some readers may wish to pursue this idea with some of the stars listed in the companion article in this newsletter (see page 23) and also on some of the brighter Miras with humps. But let's turn our attention to a star with quite prominent and reasonably regular humps - R Telescopii.

Observations of R Tel

This star is reasonably bright and there is a good set of BVRI measures from Giorgio di Scala as well as BVR from Neil Butterworth, V measures from Carlos Colesanti and visual from a range of observers. These are shown in Figure 2 folded to the light elements of JD 2453245 + 467. The interval selected was from JD 2450000 to date as this covered the period when photoelectric measures became available. Unfortunately the Auckland group did not measure this star in UBVI.

There is a divergence of V measures below magnitude 11. At these fainter levels the measures by di Scala and ASAS3 are still close but the mixed V measures diverge, although remaining similar to the visual values. Some research by Arne Henden suggests that the early V observations, which show the largest divergences, were based on an old sequence the origins of which are not clear. It was certainly not measured at Auckland with other sequences for the RASNZ VSS. The sequence was updated in 2013.

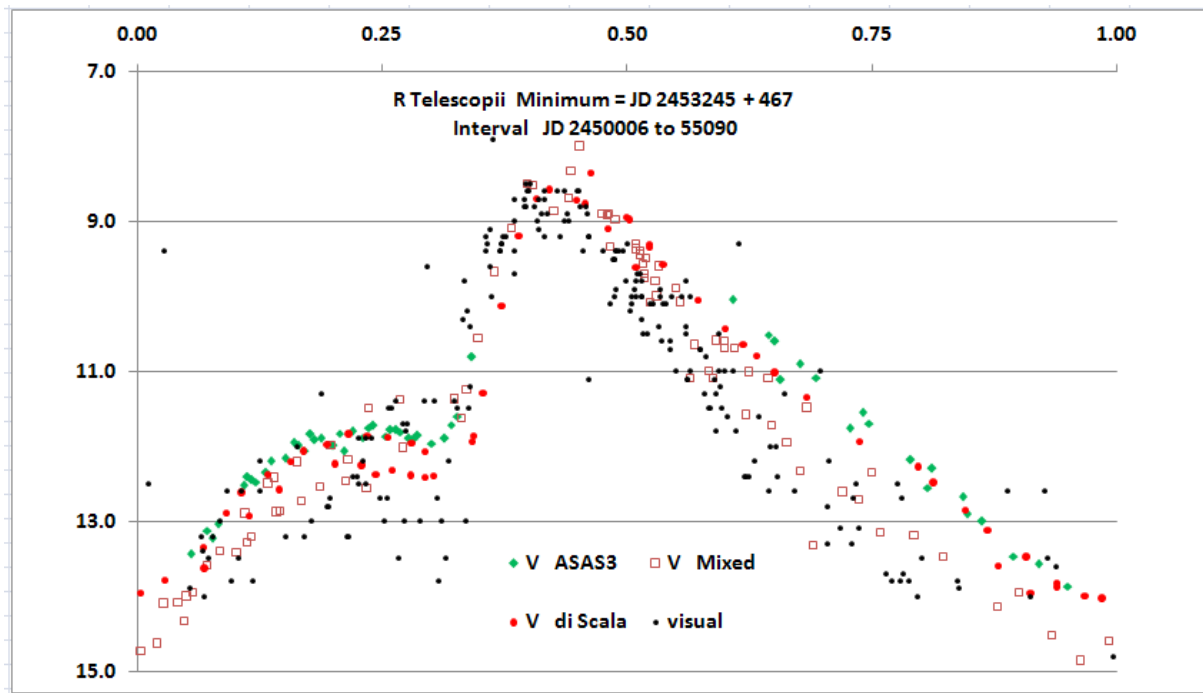


Figure 2. Observations of R Tel from a number of observers between 1995 and 2009

ASAS3 and di Scala both use all sky photometry - the mixed data and the visual measures presumably use the earlier AAVSO chart and photometry tables. Below magnitude 11 the V measures in the earlier part of the mixed dataset differ by up to and over a magnitude from the other two datasets. So we will mainly use the measures by di Scala and ASAS3 in this review.

The first ASAS3 graph, figure 3 below, confirms that the range is from 8.0 to 14.0 during this interval apart from two isolated measures which are probably faulty. The period of 467 days is used in our analysis although Andrew Pearce pointed out that the period was slowly changing during the interval up to JD 2455000 and had now fallen to ~455 days. It was reasonably consistent during the interval of the di Scala/ASAS measures so has no effect on the conclusions.

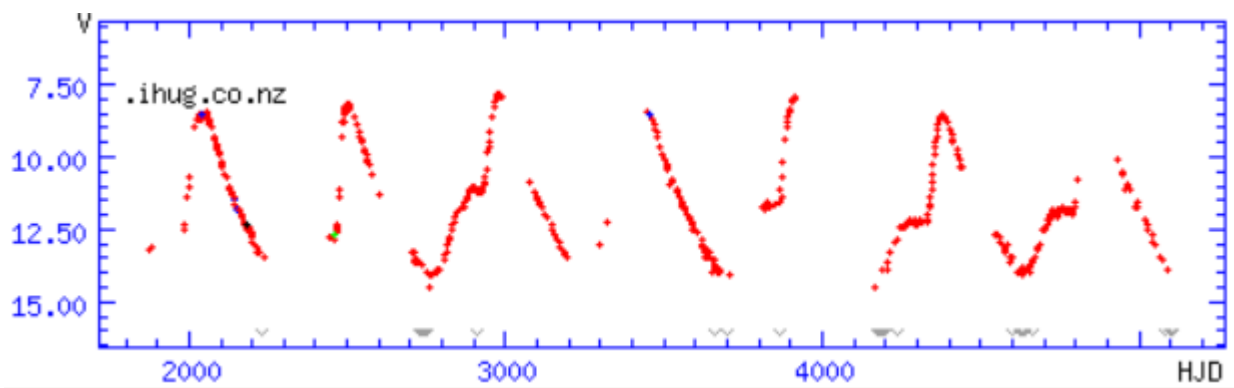


Figure 3, ASAS3 data showing the magnitude range of R Tel from 8.0 to 14.0

The next pair of graphs in Figure 4 overleaf use the same light elements. The first is based on individual filter measures - not the normal method but it allows a much clearer view of the rise to maximum with humps and the fall. All BVRI measures are included. On the right the V light curve and colour changes, B-V, V-R, V-I, are shown, but the graph uses only the di Scala and ASAS3 measures. Thus the differing heights of the humps are real in this. The V light curve has been offset by -4 magnitudes on the right graph to allow a better scale.

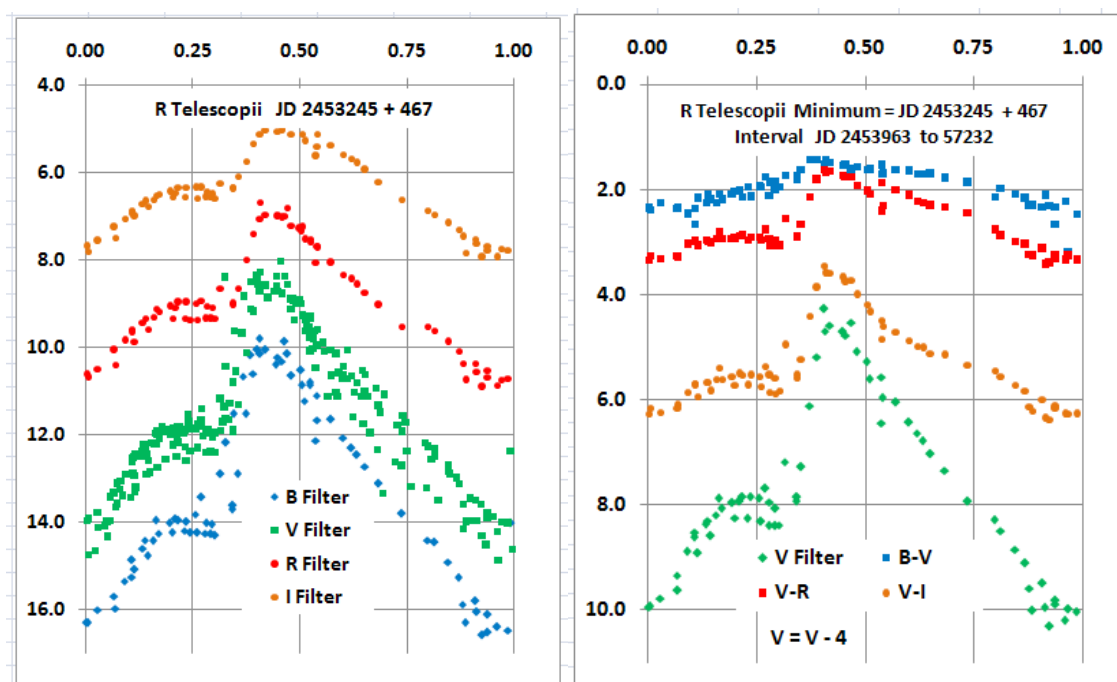


Figure 4. Individual filter measures from di Scala, ASAS3, Colesanti and Butterworth (left) with V, B-V, V-R and V-I from di Scala and ASAS3 (right)

It's not particularly noticeable in these graphs but maximum is dependent upon wavelength, occurring later as the filters move to red and infra-red. So whilst the left graph gives an indication of the amplitude in each filter passband only the V filter is useful in determining periods and changes. The earlier V measures by Colesanti using the faulty sequence are important in this context and can be corrected and used in a more detailed analysis of this star.

At the right the graph shows 'colours' or the differences between pairs of filters. In theory the B-V colour provides a reasonable guide to the temperature of the star being measured. So the change from 1.4 to 2.3 suggests the star is hottest at maximum and coolest near minimum. This is in keeping with the spectral range of M5IIe to M7e from the GCVS. Allen's Astrophysical Quantities gives B-V = 1.63 for an M5III star, B-V + 1.80 for an M5I star so the emission has affected the B-V colour by about -0.30 given the MK designation of II in the spectrum. The B-V amplitude is unusually large and is almost certainly affected by ejected gaseous material.

Conclusions

What all of this means will become clearer as more of the stars where we have colour measures are analysed. The whole UBVRI set is desirable in the dual maxima cases and perhaps in the hump stars but BVRI will provide valuable astrophysical information. The question being considered is whether these features are some mix of periods or an astrophysical feature based upon chemical composition, temperature or something else. These latter possibilities are best explored using colour photometry or spectroscopy but will require time and patience.

This star is a superb example of the interesting hump feature of Mira light curves, but for more background and a discussion of observing methods and requirements please see the article 'The Variable Stars South Double Maximum Project Extended' on page 23.

Abstract

In the analysis of binary stars Kepler's third law is frequently used to combine facts on the system's speed and orbital period to allow inferences on the masses of the components. The 'mass function' thus arising is reviewed. In particular, for spectroscopic binary systems the radial velocity amplitude, period and eccentricity yield a mass function that contains a constant whose value has been frequently given as 1.0385×10^{-7} . Modern data show that this number may be $\sim 0.2\%$ in error, i.e. the value **1.036149×10^{-7}** is preferable. While the discrepancy may seem small, it becomes significant in the context of precise modern data, especially for single lined spectra where there may be a low mass (planetary) companion.

1. Introduction and motivation

In the analysis of spectroscopic binary stars, if only one component of the binary's spectrum can be identified, the amplitude of the single radial velocity curve, determined from the Doppler shifts of the spectral lines, is commonly used with the observed period and eccentricity values, to construct a 'mass function'. Although this will not furnish both masses directly, it can give insights into their likely values.

The formula used (for example, in the 8th edition of the Spectroscopic Binaries Catalogue of Batten, Fletcher & McCarthy, 1989) generally contains a numerical constant C , say, related to the conversion of units, and frequently given as $C = 1.0385 \times 10^{-7}$. This constant can be connected to the astrophysical quantity $GM_{\odot}$ (the Gaussian gravitation constant)¹, now known to many decimal places. If we insert modern values C turns out close to 1.03615×10^{-7} . Although the difference looks small, modern spectroscopy routinely determines K values to a precision where such a discrepancy becomes significant. It seems that the number 1.0385×10^{-7} has been generally retained since its introduction about 100 years ago, surviving by constant repetition although knowledge of the underlying data has improved considerably in the intervening decades.

For a long time this topic had relevance for the classical Algol group of binary stars, where only the primary component's spectrum readily stands out. Since the 1980s, however, improved spectrographic methods have allowed direct identifications of the secondary star's features in an increasing number of Algols. In the case of the so-called 'R CMa Algols' (Budding, 1989), where there may be unusually low mass components present, the point takes on added significance.

This is also becoming increasingly relevant to the growing data collections of exoplanet spectroscopy (cf. Torres, 2010). A connected point, related to the evolution of interactive binary evolution and planets, was raised by Eggleton (2005), who noted the special role that third bodies of very low mass might play in a more general angular momentum scenario.

The next section of this paper reviews historical background on the mass function and related topics. Section 3 focuses particularly on the appropriate numerical value of the constant used in radial velocity applications to binary systems.

2. Binary star motion and Kepler's third law

Ideas about the masses of gravitationally bound stars can be traced back to William Herschel's (1803) famous paper on the "Situation of Double-stars and ... the Cause to which they are owing". At that time, Herschel announced that the bright components (A and B) of Castor form a gravitating pair, to which

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1 The product $GM_{\odot}$ is known to a much higher accuracy than either the gravitation constant G or the solar mass $M_{\odot}$ are known individually.

Kepler's Third Law, in the same form as for the Solar System, might be applied. This was taken to be a direct demonstration of the general nature of Newton's Law of Gravity, at least to distances very much greater than that of the Sun.

A related idea occurs in the formula for the so-called dynamical parallax π_d of a visual binary (Seares, 1922) as

$$\pi_d = \alpha / \{(M_1 + M_2)^{1/3} P^{2/3}\} \quad , \quad (1)$$

where P is the period in years, α is the apparent semi-major axis of the secondary about the primary in arcsec and M_1, M_2 are the masses of the two stars. The quantity α is more directly measured than individual semi-axes about the system centre of gravity. If only the primary star were visible and we could measure the angular semi-major axis of its orbit a_1 , we could write

$$\begin{aligned} \pi_d &= a_1 (M_1 + M_2) / \{M_2 (M_1 + M_2)^{1/3} P^{2/3}\} \\ &= \{a_1 / P^{2/3}\} \times [(M_1 + M_2)^{2/3} / M_2] \quad . \end{aligned} \quad (2)$$

The known quantities a_1 and P are factored here by the item in square parentheses that involves the stellar masses. While stellar masses can be estimated from other observations (eg spectra), if only one component is observed this mass term is not directly specified. If an estimate of the parallax can be made separately, a value of M_2 may then be deduced.

A similar calculation can be applied to the 'light time effect', when an eclipsing pair may have a distant companion with which it shares a wide orbit around a common centre of gravity. In that case, the amplitude of the periodic timing differences for the eclipses of the close pair a_{ct} , say, come from the varying distances projected in the line of sight. The binary orbit itself would be inclined to this line at an angle i , say. The corresponding form of Kepler's Law becomes

$$a_{ct} = P^{2/3} \times [q \sin i M_1^{1/3} / (1 + q)^{2/3}] \quad , \quad (3)$$

where the mass ratio M_2/M_1 has been written as q .

So this type of formula — essentially Kepler's third Law applied to one component of a binary system — is generally rearranged so that the quantities not directly known, in particular the masses, are on one side and measurable values on the other, i.e.

$$\begin{aligned} f(M) &= M_1 q^3 \sin^3 i / (1 + q)^2 \\ &\equiv f(\text{observables}) \quad , \text{ e.g. } C f'(\pi, \alpha, P) \quad , \end{aligned} \quad (4)$$

where C is a constant that takes into account the observables in question. For stellar binaries, these are not usually in the same units (solar mass, AU, year) that would naturally apply to the solar system. Still, the function written as $f(M)$ in (4), with M in solar masses, is the **mass function**: the subject of this paper.

3. The constant used in spectroscopic mass function evaluation

Vogel (1889) and Pickering (1890) pioneered the application of the Doppler principle to spectroscopic data, thereby confirming Keplerian motion, and indeed it often turns out that one spectrum only is identified (the 'single-line' spectroscopic binaries). The observed radial velocity for a binary component arising from orbital motion (cf. e.g. Smart, 1931) is written as

$$V_{r1} = K_1 \{\cos(v + \omega) + e \cos \omega\} \quad , \quad (5)$$

where, in the usual notation, e is the orbital eccentricity and the measurable (primary) amplitude K_1 is then

$$K_1 = 2\pi a_1 \sin i / \{P(1 - e^2)^{1/2}\} \quad . \quad (6)$$

Here we have written a_1 for the semi-major axis of the primary's orbit about the system centre. The mass function is then written, with a little rearrangement, as

$$f(M) = C(1 - e^2)^{3/2} K_1^3 P \quad . \quad (7)$$

C would be simply $1/8\pi^3$ if the speed K_1 (κ_1 , say) was in astronomical units per year, and P (p , say) was in years, so that

$$f(M) = (1 - e^2)^{3/2} \kappa_1^3 p / 8\pi^3 \quad . \quad (7a)$$

But usually K_1 is measured in km s^{-1} and P in d, so we write $K_1 = (A/DS)\kappa_1$ and $P = Dp$, where A is the number of km in an AU, D is the number of days in a year and S the number of seconds in a day. Converting from κ_1 and p to K_1 and P , we have

$$C = D^2 S^3 / (8p^3 A^3) \quad . \quad (8)$$

Kepler's Law for the Sun Earth system, written as $4p^2 A^3 / D^2 S^2 = G(M_\odot + M_E)$, allows Eqn (8) to take the alternative form

$$C = 86400 / 2\pi G(M_\odot + M_E) \quad , \quad (9)$$

where the unit of length is in km for practical applications. The mass of the Earth M_E , being $\sim 3 \times 10^{-6} M_\odot$, is usually neglected: its inclusion would make C 0.0003% smaller than the generally adopted value.

Equation 9 shows the constant C to depend essentially only on the fundamental constant G and the solar mass, at least for the first 6 digits. It may also be kept in mind that the number of seconds in a day is not strictly a matter of definition, and occasionally 'leap' seconds are added to calendar days in order to regularize different systems of time measurement. This particular correction turns out to be very small, however, in comparison to other relevant estimates of the Gaussian gravitation constant $GM_\odot$.

Historically accumulated astrometric data on the mean apparent motion of the Sun gave the constant **$GM_\odot$ as $1.32712\ 51 \times 10^{26}$** (in cgs units — cf eg Allen, 1974)². A more recent value for the Astronomical Unit is 149597870 km, which is a factor of 2 units in the eighth digit smaller than the older value. The corresponding effect is to reduce the Gaussian constant to **$GM_\odot = 1.32712\ 46 \times 10^{26}$** (cgs). A more up-to-date value for the sidereal year has effects that are two or more orders of magnitude less than the uncertainty in the AU.

This result may be compared with much more recent determinations of the Shapiro effect in pulsar observational data, from which a value of **$4.925490947 \times 10^{-6}$ for $GM_\odot/c^3$** has been cited by various authors. With c (defined) as $2.99792458 \times 10^{10} \text{ cm s}^{-1}$, we find **$GM_\odot = 1.32712\ 44 \times 10^{26}$** , which is 0.00002% less than the value determined from observations of solar system objects, but this difference is far less than that of present concern, which relate to frequently cited values of the constant C as applied to observations of binary systems.

W M Smart, referred to above in connection with the radial velocity formula (see also Smart & Green, 1936), gave the constant, for velocities in km s^{-1} , as $C = 1.038 \times 10^{-7}$. That, or something quite similar, appears to have been generally adopted in numerous papers and texts on spectroscopic binaries over the next half century and more. Indeed, Smart's value is numerically the same as that in the original review of Ludendorff (1911), who may have been the first to apply the mass function in this form to spectroscopic data, although a number of earlier authors were thinking along similar lines (Frost, 1896).

Ludendorff's investigations of mass function data clearly stimulated the attention of many later binary system analysts, e.g. Russell et al, 1923; Maury, 1925; Struve, 1927, and so on, so that even up to recent times we can still find this number quoted (Pourbaix et al., 2004). In fact, until relatively recently, the value of C given by Ludendorff was probably adequate for the great majority of available data-sets of

² The numerical constant here would be multiplied by 10^{11} rather than 10^{26} when using Eqn 9 to apply to velocities in **km s^{-1}** .

binary system radial velocities. This is, however, some 0.25% different from the value of $C = 1.0361491 \times 10^{-7}$ corresponding to the latest value of $GM_{\odot}$. This value would yield **29.78471 km s⁻¹** for the mean orbital velocity of the Earth ($= [CD]^{-1/3}$) over the sidereal year to the nearest cm s⁻¹, a precision to which an improved, but practicable, version of Mt John's *HERCULES* spectrograph (Hearnshaw et al., 2002) may become capable of measuring. Note that if we include the mass of the Earth in Eqn (9) for C the corresponding mean velocity would be increased by about 2 cm per second.

Eqn 4 can be rearranged to produce a cubic for the mass ratio q of the form

$$0 = q^3 - Ckq^2 - 2Ckq - Ck \quad (11)$$

where $k = (1-e^2)^{3/2} K_1^3 P / (M_1 \sin^3 i)$ may be regarded as increasingly well determined with improving technology. This cubic's real root then becomes relatively more sensitive to the value of C for the small values of q expected in the contexts mentioned above. For 'warm jupiters' we should expect variations in the radial velocity of a host star in the order of 0.1 km s⁻¹, which appears well above the precision limit just mentioned, yet when compared to spectroscopic binary radial velocity amplitudes, begins to compare with the error of the conventional value of C . It is thus desirable to use the best available value of C for use in spectroscopic research of systems containing components of relatively low mass.

4. Acknowledgement

The author appreciates the suggestions of Peter Eggleton to check up-to-date information on the value of the mass function constant.

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Abstract

As part of a continuing programme of study of the Innes variables (UOC 20, 31 and 37) I present a study of 42 of his stars, out of 174 new objects. These have been particularly problematic, and often hard to identify. Apart from a small number previously identified (Morel 2012), some have still only approximate coordinates. This paper now provides notes and astrometric positions for more stars, previously unknown due to poor positions. The number of unidentifiable Innes stars is reduced to three; another nine can be rejected for various reasons : constancy, plate defects etc.

Introduction

The best 1875 positions provided by Innes (1914, 1915 & 1917) for his 174 variables were assembled and precessed forward to equinox 2000.0, although stars numbered higher than 143 have positions of lower precision (nearest 0.1m in RA, and whole minute of declination). All of his published observations, especially UOC37, Table III, were studied, as well as any identifying notes or hints. Blue plate images of each field, from the *SuperCOSMOS Sky Survey* were regularly employed. Modern online survey catalogues were used in searching for (or rejecting) likely candidates. Cutouts (5'x5') from *SuperCOSMOS* images are attached for twelve variables, whose proposed identifications may still, in a few cases, prove to be contentious. See plates 1 and 2.

Summary table

Table 1 (attached) provides a summary of the 42 problematic stars, even though the problems have now been resolved in the majority of cases. Most columns are self-evident, except for:-

- “Mag” : A mean photo-mag from Innes’ observations. Said to be on the Harvard scale..
- Astrometric position : No source is given, as they are all consistent with UCAC3/2MASS/VSX. If no improvement on Innes, this section is left blank.
- “S” = current status: A coded letter indicates whether variable, or otherwise.

Notes

Innes 1 = LN Sgr. Innes position badly out. Said to be 6s foll. a 10.4mag star. Is actually 4s foll. CoD-33°13147 = TYC 7397 2488, 11.215V. LN Sgr is listed in HB861, pp9-10 (star #10, no GCVS name). No position given, but discovery name Innes 1 is noted.

Innes 3 = NSV 10783. Variable. See Morel (2012). RVA type.

Innes 4a. NOT IN NSV. (J2000) 18:26:49.61 -27:06:46.7. B-V=+1.50 Bright (10.6) July 1916, otherwise 17: Doubtful (Innes). Defect? Rejected as variable.

Innes 5 = NSV 10802. See Morel (2012). Confirmed; SRB.

Innes 7. NOT IN NSV. 16.2-17; (J2000) 18:27:19.68 -27:14:25.9. 15.54V (GSC2.2). Always vis.(Innes). Constant.

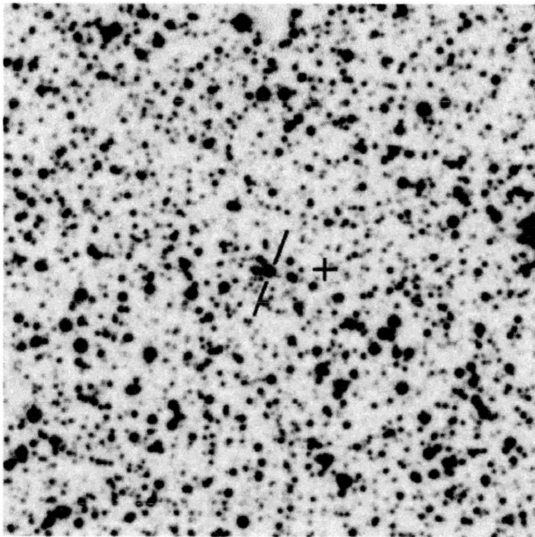
Innes 111. NOT IN NSV. (J2000)18:28:43.60 -35:40:52.6”. Observed bright (11.5, 1915 Aug.6). No variability. Rejected by Innes.

Innes 21 = NSV 11004. Confirmed var. SR type. See Morel (2012).

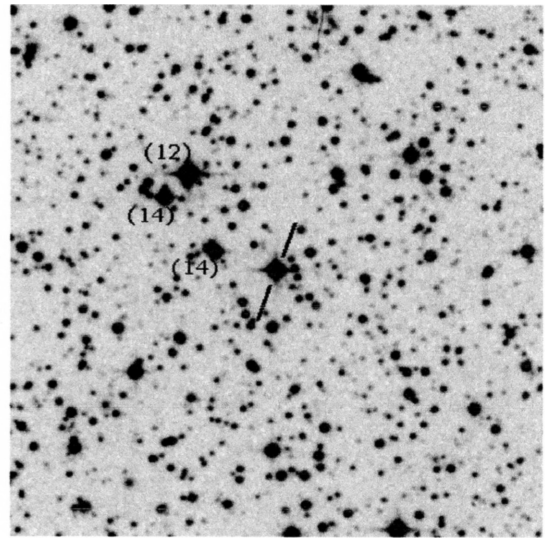
Innes 28. REJECTED-DEFECT. UOC20 note: “Image on 1910 Sept. very strange-elongated with six sides. Nearby stars are similar.”

Innes 118 = NSV 11057. 13.5-14.5. (J2000) 18:35:49.82 -29:08:40.6. Obs. fairly steady at 14.0. V=14.385, B-V=1.367 APASS

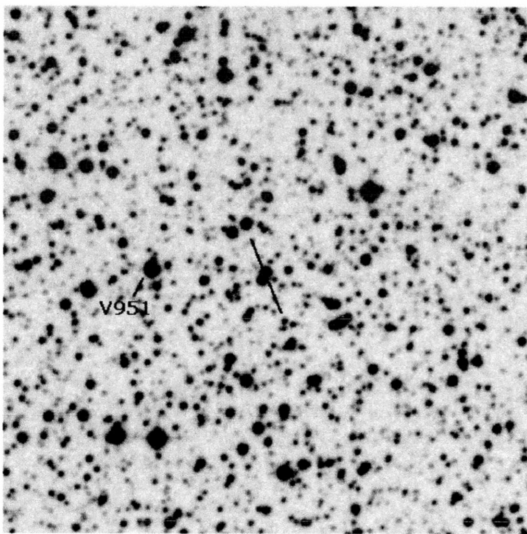
Innes 39 = NSV 11123. 15.3-16.5 (J2000)18:38:19.83 -31:05:59.3 See Fig.1. Candidate, is just 2.7s east of Innes position.



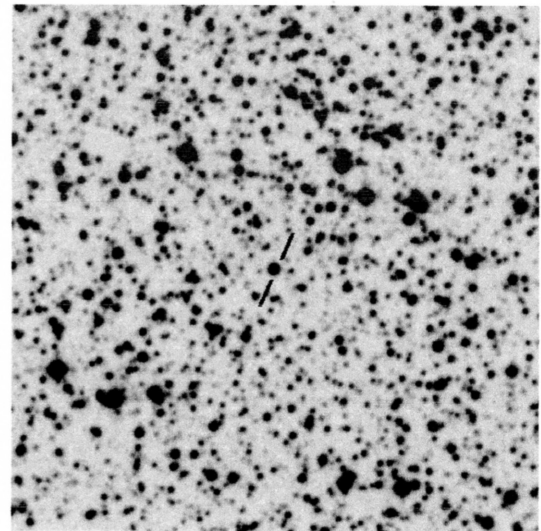
(1). Innes 39. His catalogue posn marked by cross.



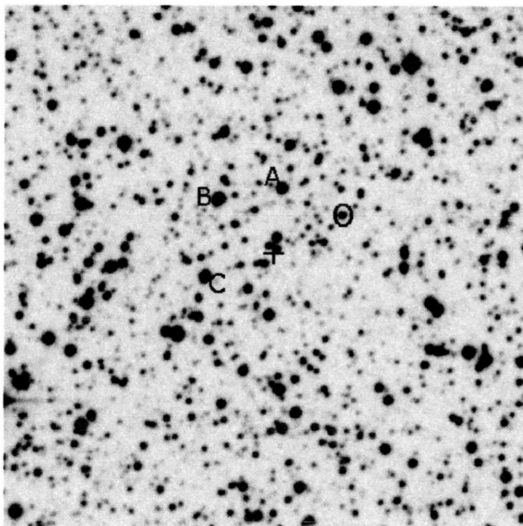
(2). Innes 146. Other field stars labelled according to Inne



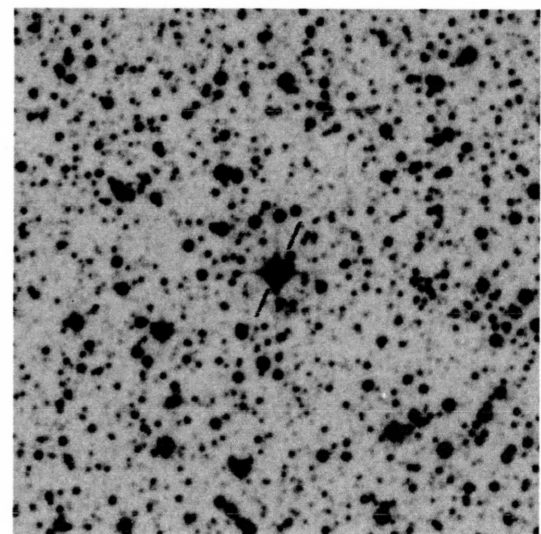
(3). Innes 146a. Lies 0.1m preceding V951 Sgr (M).



(4). Innes 150. Provisional identification.

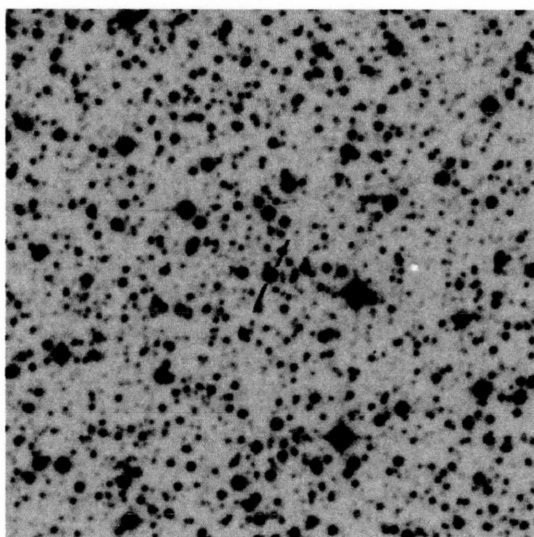


(5). Innes 62. Uncertain. Circled star was suggested by Morel (2012), now rejected - too faint. The correct star is likely to be A, B or C. C is more likely.

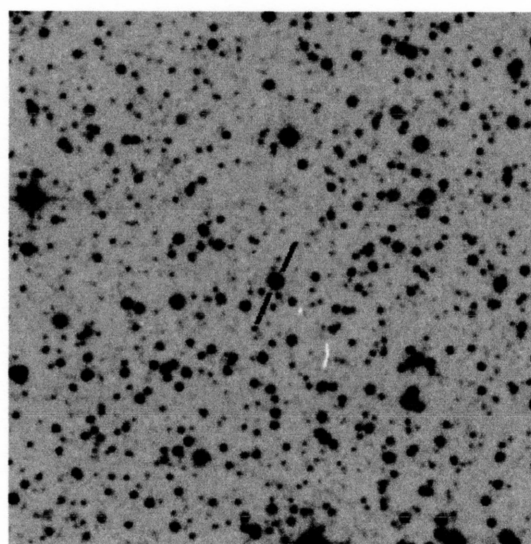


(6). Innes 156. TYC 7408 388, B=11.75.

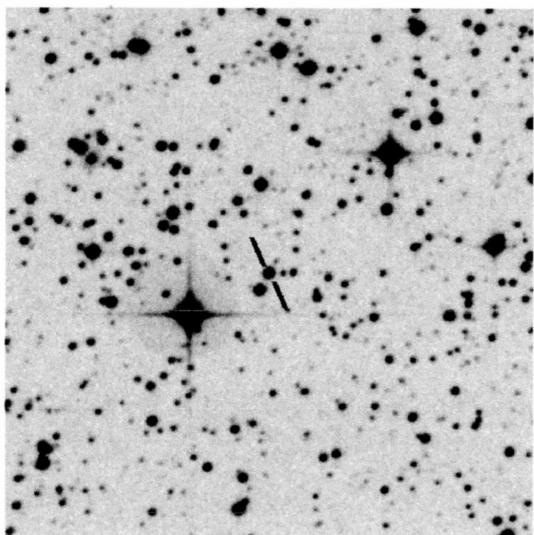
Plate 1. Figs 1 - 6. All charts have N up, E to left. 5' field. UKST blue filter.



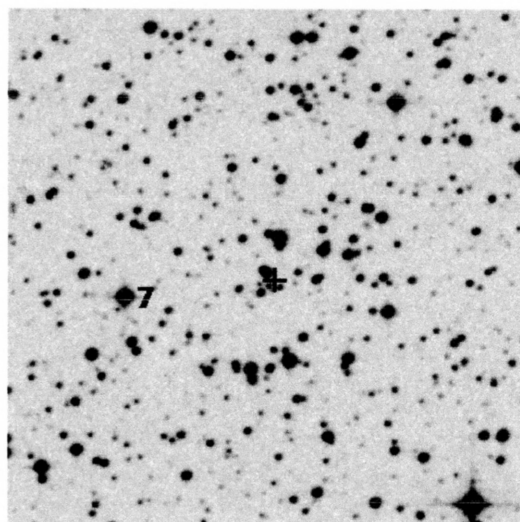
(7). Innes 157. Provisional identification.



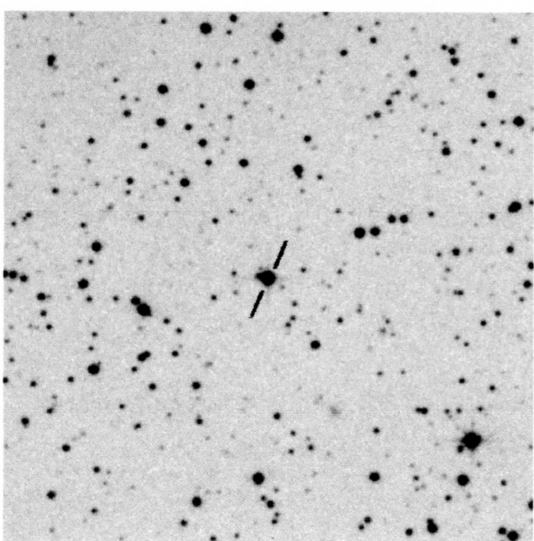
(8). Innes 133. Provisional identification.



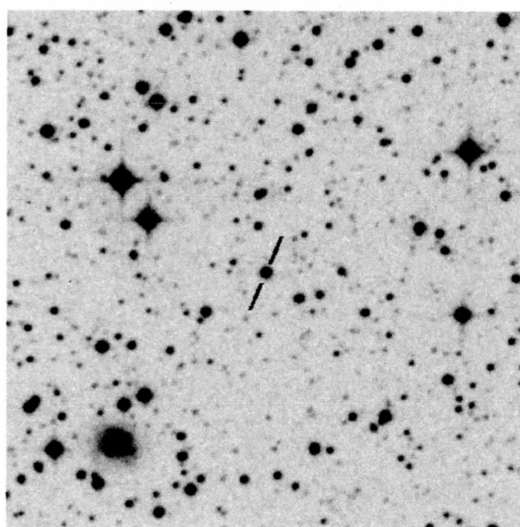
(9). Innes 136. Secure id. Fainter comp. of close pair.



(10). Innes 163. Uncertain. Lies in a ring of faint stars, of which 7, 14.33B, is clearly the brightest.



(11). Innes 164. Secure id. RRC type. See text.



(12). Innes 142. Provisional identification.

Plate 2. Figs 7 - 12. All charts have N up, E to left. 5' field. UKST blue filter.

- Innes 42 = NSV 11150.** Confirmed. See Morel (2012). SR, 11.90-13.2V
- Innes 42a = NSV 11151.** 13.8 - <16 Obs. fairly steady, 13.8+/-0.2, except on 1913 July 28 (JD 2419977) when missing, <16. Thought to be EA: However, nothing in the vicinity matches. Either the position, or the magnitude scale, is in error. NOT FOUND.
- Innes 122 = V948 Sgr.** Innes position off by 19s. Correct in VSX.
- Innes 123 = NSV 11164.** Nonexistent. Probably confused with minor planet 563 Suleika acc. to GCVS. At 14.0 on JD 2420716; usually <17.
- Innes 47 = MQ Sgr.** 15.5p Variability could not be established from his observations, and therefore retracted by Innes. His position is consistent with a mira variable. (J2000)18:41:12.67 -28:03:36.9.
- Innes 146 = NSV 11214.** Is part of a group (one 12 and two 14s), (J2000) 18:42:45.72 -37:44:19.7. Innes position is off to the west. My identification seems secure. Range 12.2-14. Evidently the same as ASAS J184246-3744.4, 11.87(0.66)V See Fig. 2.
- Innes 146a = NSV 11208.** This star (and 147=V951 Sgr) are both offset to the west by 6s and 5s respectively. When both positions are adjusted eastwards they both match with stellar objects. I take 146a to be the close pair at 18:42:22.15 -31:13:59.7. See Fig.3.
- Data: V=14.583(0.0) B-V=0.787(0.059) APASS Probable blend.
- Innes 148 = V954 Sgr.** Innes' RA is off, too far W by ~15s. Range agrees, but not period. (J2000) 18:43:05.78 -35:04:33.8.
- Innes 52a = NSV 11220.** New id. by Kazarovets & Pastukhova (2015). See also Morel (2012), plates 9a and 9b. NSV 11220 = star 'c'
- Innes 150.** NOT IN NSV. Range 12.5-17: Only one max. observed 1916 July. Provisional id. is star at (J2000) 18:43:14.87 -30:29:15.2.
- Data: V = 15.142(0.011) B-V = 1.271(0.069) APASS (29). See Fig.4. Variability unconfirmed.
- Innes 62 = NSV 11286.** Range 14.5-17. ID unclear. See Morel (2012), plate 11a. The star marked there would, nevertheless, be too faint, at 17.91B (GSC2.2), to appear on Union Obs. plates. The faintness of this star is confirmed by study of UKST blue plate. See Fig.5. The coordinates given by Innes are plotted with a cross. There are three nearby 15mag stars, labelled A, B and C. Their B magnitudes are 15.91, 15.37 and 15.86 respectively. I regard C as the best candidate for Innes 62. Its position is (J2000) 18:45:24.66 -32:11:42.2 V=14.898, B-V = +0.965 APASS (29).
- Innes 153 = NSV 11313.** Range 13.8-15.4. 17 observations by Innes yield $m = 14.75$ (mean). NSV type RR: Nothing matches at Innes posn. I note that V453 Sgr (RRAB) is 32s following. By adding 32s to Innes' 1875 RA, and recalculating its J2000 position, this yields 18:47:01.1 -35:50:14, essentially identical to V453 Sgr, with median $m=14.55$. There is little doubt that **153=V453 Sgr**.
- Innes 156 = NSV 11360.** Range 11.6 - 17: Innes describes it thus: "*close to a 12 and slighter brighter than it on all plates except three*". From inspection of a Franklin Adams blue plate, used for Union Obs. chart 114, only two stars, lying E-W, which may fit.
- TYC 7408 388 B=11.75, B-V=0.414 APASS (29)
- TYC 7408 354 B=11.98, B-V=1.186 APASS (29)
- Innes estimated **156** at 11.7 on 1912 June 21 (JD 2419575), the very same date of the FA plate. It was an easy matter to confirm his estimate, and the relative brightnesses of the Tycho stars. Thirteen of Innes' estimates lie in the range 11 - 11.7, mean ~11.5, while 3 estimates are very faint (17:).
- ASAS J184930-3110.0 lies even further east and has recently been identified as NSV 11360 by Kazarovets and Pastukhova (2016). The ASAS variable is too faint in blue light at <13.0B to appear on the FA plate, and should be rejected. The two Tycho stars, 388 and 354, appear to be the only realistic matches for the 12mag stars cited by Innes. There is a problem - the brighter of the two is 7408 388, and the better match, but it lies further away from the published position. This implies a

very poor position. The Innes variable was found faint on only 3 plates. Intermediate brightness do not appear at all. NSV type- EA: My tentative identification is : **156** = TYC 7408 388. See Fig.6.

Innes 157 = NSV 11362. Range 14.5 - 17. (2000) 18:49:14 -30:46.8 Innes' position is quite close to 2MASS 18491433-3046417.

Data. J=11.754 Ks=10.864 B-V=1.424

B=15.3 A2.0

V=14.197 (0.034) APASS (29)

B-V=1.388 (0.080)

The identification with a small range variable seems likely. See Fig.7 Confirmation is required.

Innes 79 = NSV 11517. (J2000) 18:55:26.55 -26:41:42.6. Variable in ASAS, M type, P=221d. [Wrong coords in Morel(2012)Table I.]

Innes 129. Range 16.0 - <17.0. NOT IN NSV. Usu. 17 or fainter; at 16.0 on one plate only. "Grey" acc. to Innes, implying a red star, at (J2000) 18:57:42.70 -32:05:57.0 Rejected by Innes.

Data: J=8.570 Ks=7.229 B-V=2.15 2MASS.

B=15.6 V=14.0 A2.0

Innes 132. NOT IN NSV. 9.2 on 1915 Aug.6 (UOC 31); otherwise <16.5 or <17. Probable defect?

(J2000) 19:00:28.60 -29:31:53.7 Object discarded in UOC 37

Data: J=13.884 Ks=13.567 B-V=0.507 2MASS

V=15.268(0.026) B-V=0.838(0.065) B=16.106 APASS

Lies in the middle of a relatively open region. CONSTANT.

Innes 133. Range 15.2 - 17. NOT IN NSV. Period short (Innes). Seems to be a star close to plate limit. Candidate lies at (J2000) 19:00:54.43 -32:36:33.4 See Fig.8.

Data: J=11.862 Ks=11.060 B-V=1.283 2MASS

V=14.366 B-V=1.347 B= 15.713 APASS

A red star. ASAS LC: scatter 14.0-14.7V. Id. seems secure; not confirmed.

Innes 82 = NSV 11633. 12.5 - 14.5 Confirmed. SRB. See Morel (2012) plates 13a,13b. "Small range, but certain" (UOC37). An observation of 12.5, 1914 July 23 (UOC20) is anomalous.

Innes 161 = NSV 11646. 14.0-16.5p Id. uncertain, no clear candidate found. In a field of faint (16p) stars. Rarely as bright as 14, usu. 1-2mag fainter. Not V5835 Sgr, 9s away. NOT FOUND.

Innes 83 = NSV 11638. 14.5-15.5. Confirmed mira var. 12.5-<15.0V. See Morel (2012) plate 14.

ASAS J190112-2738.9

Innes 136 = NSV 11712. 16 - <17. Var. has a very close 16.5 companion 11" sf. This situation agrees with Innes' description; southern star is ~0.3 brighter, acc. to GSC2.2. See Fig.9. Fourteen observations by Innes (UOC37, Table III) give an average m=16.8, ie ~0.3 fainter than the companion. V = 15.80 GSC2.2. (J2000) 19:05:40.73 -36:23:18.9

Innes 163 = NSV 11716. 13.0 - 15.5. Within a ring of 14-16 mag stars. Innes 163 always vis.; 19 observations reported (UOC37), m=14.48(ave). Star 7 is brightest at 14.33B, and taken as provisional id. (J2000) 19:05:54.76 -35:10:11.9 See Fig.10.

Data: V = 13.254(0.024) B-V = 1.074(0.041) APASS (29).

Innes 164 = NSV 11739. 13.6-14.8 RRC type, found by Kazarovets and Pastukhova (2016). Innes places it more east by 15s. See Fig.11.

Innes 168 = NSV 11778. 13.8-16.5 On Innes' plates I note a tendency for this one to swing between two states - high ~13.8, and low, ~16.0. No ASAS data. NOT FOUND.

Innes 103 = NSV 11851. 13.8-14.6, SR. See Morel (2012), plate 15.

Innes 171 = NSV 11860. 14.2-16.0 (J2000)19:17:07.51 -31:00:19.0 SRB, B-V = 1.99 2MASS. Innes position off by 7.5s.

Innes 140. NOT IN NSV. M = ~15.1, (J2000)19:22:49.23 -34:23:20.3 Provisional id. Non-variable. REJECTED-DEFECT..

Innes 141. NOT IN NSV. REJECTED. Film defect.

Innes 142 = NSV 11967. 15-<17 Faint on most plates, <16.5. Only bright, 15, on 1915 Aug.6. (J2000)19:24:01.74 -32:28:00.0 B=16.17, J-K=0.32 (GSC2.2;2MASS). Brightest of three 16p stars in region. See Fig.12. Non-variable.

Innes 109 = NSV 12127. 14.1-16.8 (J2000) 19:33:47.71 -36:38:47.2 See Morel(2012), plate 17. Confirmed RRAB.

Innes 110 = V347 Sgr. Typo in UOC37 - RAmin too large by 1.0min. Named as V983 Sgr before error was found; this name now obsolete.

Table 1. 42 problematic Innes objects - identified, with better positions.

CODES : Column 'S'.												
V : Confirmed variable.												
N : NSV variable (including uncertain ids.)												
S : Suspected variable (Innes star with no other name).												
X : Rejected, including constant.												
Innes	NSV, GCVS	INNES-J2000		MAG	ASTROMETRY (J2000)						S	Remark
=====												
					h	m	s	°	'	"		
1	LN Sgr	18:23:41.1	-33:23:50		18	23	15.88	-33	28	33.2	V	*
3	10783	18:26:27.6	-33:03:56	15.7	18	26	27.32	-33	3	37.8	V	*
4a		18:26:49.5	-27:06:50	17.0	18	26	49.61	-27	6	46.7	X	*
5	10802	18:27:04.7	-29:03:18	15.9	18	27	5.33	-29	3	15.0	V	*
7		18:27:19.9	-27:14:20	16.7	18	27	19.68	-27	14	25.9	X	*
111		18:28:41.7	-35:40:51		18	28	43.60	-35	40	52.6	X	*
21	11004	18:33:28.3	-30:34:15	14.3	18	33	29.31	-30	34	12.2	V	*
28		18:35:50.3	-34:59:57	<17							X	*
118	11057	18:35:50.7	-29:08:37	14.0	18	35	49.82	-29	8	40.6	N	*
39	11123	18:38:17.1	-31:05:53	15.9	18	38	19.83	-31	5	59.3	N	Fig. 1
42	11150	18:39:24.7	-28:40:10	12.2	18	39	23.95	-28	40	10.1	V	*
42a	11151	18:39:32.1	-29:02:33	13.8							N	Not found
122	V948 Sgr	18:40:20.5	-35:48:20	15.0	18	40	39.59	-35	49	14.8	V	*
123	11164	18:40:10.5	-28:54:32								X	Minor planet
47	MQ Sgr	18:41:11.3	-28:03:26	15.5	18	41	12.67	-28	3	36.9	V	*
146	11214	18:42:38.0	-37:45:02	12.6	18	42	45.72	-37	44	19.7	V	Fig, 2
146a	11208	18:42:16.4	-31:14:04	14.1	18	42	22.15	-31	13	59.7	N	Fig. 3
148	V954 Sgr	18:42:50.2	-35:04:59		18	43	5.78	-35	4	33.8	V	*
52a	11220	18:42:45.8	-33:19:41	15.7	18	42	54.18	-33	18	16.8	V	*
150		18:43:13.4	-30:28:53	16.5	18	43	14.87	-30	29	15.2	S	Fig. 4
62	11286	18:45:22.0	-32:11:37	16.1							N	Fig. 5
153	11313	18:46:29.1	-35:50:20	14.7	18	47	1.07	-35	50	23.9	V	=V453 Sgr
156	11360	18:49:09.6	-31:10:53	11.4	18	48	51.19	-31	9	26.3	N	Fig. 6
157	11362	18:49:14.1	-30:46:49	16.4	18	49	14.33	-30	46	41.7	N	Fig. 7
79	11517	18:55:26.4	-26:42:05	14.8	18	55	26.55	-26	41	42.6	V	*
129		18:57:41.5	-32:06:01	17.0	18	57	42.70	-32	5	57.0	X	*
132		19:00:29.3	-29:31:48		19	0	28.60	-29	31	53.7	X	*
133		19:00:55.2	-32:36:51	16.4	19	0	54.43	-32	36	33.4	S	Fig. 8
82	11633	19:00:42.0	-25:51:33	14.0	19	0	49.49	-25	53	43.4	V	*
161	11646	19:01:39.1	-35:44:38	14.8							N	Not found
83	11638	19:01:12.3	-27:38:58	15.2	19	1	11.92	-27	38	51.3	V	*
136	11712	19:05:41.3	-36:22:56	16.8	19	5	40.73	-36	23	18.9	N	Fig. 9
163	11716	19:05:48.1	-35:09:54	14.5	19	5	54.76	-35	10	11.9	N	Fig. 10
164	11739	19:07:24.6	-38:04:38	14.2	19	7	9.53	-38	4	3.7	V	Fig. 11
168	11778	19:10:59.3	-36:33:00	14.6							N	Not found
103	11851	19:16:15.6	-27:18:14	14.1	19	16	16.61	-27	18	12.5	V	*

171	11860	19:17:00.0	-31:00:55	14.9	19 17	7.51	-31	0	19.0	V	*	
140		19:22:48.3	-34:22:56	15.1	19 22	49.23	-34	23	20.3	X	*	
141		19:23:43.5	-28:22:45							X	*	
142	11967	19:24:04.6	-32:27:43	16.9	19 24	1.74	-32	28	0.0	N	Fig. 12	*
109	12127	19:33:48.7	-36:38:53	15.5	19 33	47.71	-36	38	47.2	V		*
110	V347 Sgr	19:32:44.3	-32:14:08		19 32	44.80	-32	14	14.8	V		*

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VSX database: <http://www.aavso.org/vsx>

Visual observing with ‘Kororia’ – *Stephen Hovell*

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Pukemaru Observatory with the north side down and Kororia poking its head out.

My new telescope arrived in late March and we haven't had a decent, clear night in the Far North since then. There have been some cloudless nights but the seeing has been pretty poor. Isn't that so often the way. But's let's go back a bit.

I like to observe variables visually — UGs, RCBs, NLs, NRs and a few other odds and ends. Most nights, the UGs are invisible but I enjoy the surprise factor of seeing them when they rise, especially the UGWZs. I also love catching RCBs on the decline and their recovery.

In 2007, I got a very nice 12" Meade LX200, a big improvement on my previous 8" reflector. But as the years went by, I wanted something bigger. I searched the internet, and looked seriously at a 16" Meade. But then I decided I would get more light grasp if I went with a big Dob. There were some really nice looking Dobs being made, and I finally decided on a one-man company called SDM (Size Does Matter) in Australia. The company is run by Peter Read. Peter lives at Bunbartha, not far from Shepparton in northern Victoria, Australia. While visiting my daughter in Sydney, I decided to pop down to Bunbartha and check out SDM (<http://www.sdmtelescopes.com.au>). I was really impressed by the quality of Peter's work. His telescopes are works of art. But they don't just look good. They perform really well.

After talking with Pete, I decided on a 24" f/4. That sorted, I paid the deposit and decided to get my observatory built. Our predominant wind is SW and most of my observing is to the south. If I had a dome open to the south, there would be a lot of wind currents in the observatory, and those winds are often cold. So I decided on a roll-off roof-type observatory. The observatory was built by an older guy, who was a very experienced builder. This project was a real challenge for him but he certainly rose to the challenge. It is 4.8m wide and 7.2m long. The actual observing section is 4.8 x 4.8. I chose this size as the telescope needed a 4.4m diameter turning circle. The storage room is 4.8 x 2.4 and is on the western side of the observatory. I did it this way round as there is a mill and the town of Kaitaia to the west. The walls are 2.4m high. I chose this height so that the wind would blow over the top when the telescope was pointing near the zenith. On the north, east and west sides, a 1.2 x 3.6m section can fold down allowing me to get closer to the horizon. This is more important in the south so that I can follow the deep southern variables for longer.

I named the observatory Pukemaru after the name of our property. It means 'the hill of shadow', or 'the hill of shelter'. We have 10 acres, situated up a windy, dusty (at this time of year, muddy) road, 11km south east of Kaitaia in the Far North. There is a 90 metre walk up the hill from my home. My farmer neighbour runs his stock in the paddock leading up the observatory, and the big pug marks in the ground used to be quite tricky to navigate especially when the ground dried out in the summer. So I had a path-way made with electric fences on each side.

The person who was originally making my mirror was no longer able to do it – I think he stopped doing mirrors, so Peter suggested we go with Mike Lockwood, of Lockwood Custom Optics (<http://www.locktics.com>) in the USA. Mike makes fast mirrors up to about 50". Peter suggested I opt for a 28" f/3.3 and who was I to argue. Mike got to work on the mirror and flat and Peter got to work on the telescope. Peter does not mass-produce telescopes. He contours them to suit individual needs. For example, he wanted to build mine slightly higher so that the telescope could get closer to the horizon. (I can get down to 7° with 50% of the mirror, and 50% of 28" is still pretty good).

The telescope was finally ready in March of this year. I drove down to Auckland to collect it (350km each way) and fastened it very securely onto the trailer. It was a very long, slow trip home to Kaitaia. Pete always likes to set up the telescopes himself, so he arrived at the end of March and got the telescope set up. Exciting times.

Now to the telescope itself. It is known as 'Kororia' which is the Maori word for 'glory'. It comes from the Maori Bible, Psalm 19:1: "E korerotia ana e nga rangi te kororia o te Atua" – "The heavens declare the glory of God." It has an 18 point mirror cell with a very nice feathertouch focuser. Stars snap into focus when the sky is good. There are mirror fans to cool down the mirror. There are 3 dew heaters which I have been using a lot lately! It has a rip-stop nylon shroud which I keep permanently on the telescope. It has an ArgoNavis with 10K encoders and a ServoCAT with two handpads. One is mounted on a stalk and the other wired in at the top end. This is extra handy.

There is a Telrad which I only use for alignment purposes (I have to realign when the power goes off and this has been happening quite a bit over the winter months. There is a very nice Stellarvue 11x60mm finder and an 80mm f/6 Explore Scientific APO. I was going to mount an SV 105 f/7 triplet on the mirror box but this would have made the lower end too heavy and would have created balance problems. So I use the SV 105 on a Skywatcher EQ5 Pro GoTo Mount as my travel scope.



The author in front of Kororia in the observatory.

I use Nagler eyepieces — 31mm, 20mm, 13mm, 9mm, 7mm and a 3-6mm zoom. I mainly use the 31mm and the 7mm. The zoom is handy if the stars are very close together and I need to separate them. However quality of seeing limits the extent to which I can zoom in.

The 60mm finder has a 6° FOV. I use the 80mm with a 20mm Nagler and this gives a FOV of just over 3°, quite handy for brighter variables. Most variables have a bright star (6th mag or brighter) nearby, and most of these are in the Bright Star catalogue in the Argo. So for example, RY Dor, an old nova that some of us keep an eye on, is very close to Theta Dor. So I just dial up Theta Dor, push the button and the telescope goes there. The star is right in the FOV of the main telescope. If the variable is a little further away, I use the 60mm or the 80mm and star hop.

Do I use a ladder? Sometimes. At this time of year, stars like VW Hyi, TU Men and W Men are quite low so no ladder is needed. I have a 3-step ladder which is fine for me and most of the time I am just on the first step. But when the likes of my 3 year old granddaughter, Phoebe, comes up, I need to use a big ladder.

I showed Phoebe Jupiter in the sky, which she took to be a star. Then I showed her Jupiter through the telescope. I could see her little mind trying to rationalise the telescope view with the naked eye view.

Most nights I can get down to about mag 16.5-17.0, and I have glimpsed 17.3 in the field of RU Hor. It's quite exciting to be able to see this faint regularly. Most nights I can see Z Cha at minimum around 16.0. At the time of full moon, I can just see 15.0. But remember earlier that I said the weather has not been the best, so roll on some decent weather. I thought I'd try stars in the daytime about an hour before sunset. I saw Jupiter with the two main bands. It looked funny with a blue background. I also saw Alpha Crucis, easily. I will try some other stars when it is fine!



The author's granddaughter, Phoebe aged 3. She is learning the planets.

Like a few other of our members, I submit my observations to the AAVSO. The AAVSO has an excellent site called VSP, Variable Star Plotter, and you can produce whatever scale charts you want and down to whatever magnitude you want. I tend to use a 6' FOV down to about mag 18.0. There was one big problem with having a larger telescope for us southern observers – and even in the equatorial regions – the sequences didn't go faint enough, and that is even if the sequences existed in the first place. The AAVSO offers two excellent areas of support.

The first is **Request Comparison Stars for Variable Star Charts**. From their website: "the AAVSO Charts and Sequences Team is now revising and creating new sequences for variable stars at an amazing pace. If you wish to begin observing a variable star that does not have an AAVSO comparison star sequence, you can request one be made. These requests are frequently fulfilled in 48 hours or less if reliable photometry is available." All you do is submit the name of the variable, coordinates, type of variable, magnitude range, chart scale, whether it is for visual or CCD, and state whether it is urgent or not.

The second is CHET, the **Chart Error Tool** (<https://www.aavso.org/chet>). This allows members of the AAVSO to report errors on charts but more importantly for me, request fainter sequences. They have an excellent team who respond very quickly to such requests. So pretty much all of the stars I observe now have sequences down to 17.0+. I believe Mati Morel is a member of their team.

My latest request to CHET was for a few fainter comparison stars for DX Oct. This star is an NL with a range 13.1 – 14.4 V. One night in late June, it was visible but fainter than 15.0 The sequence stopped at 147 so I requested extra comparison stars. I had them in less than 24 hours and was able to use two of the new comp stars the very next night. The variable was 15.5. This star had never been seen so faint visually before, but Patrick Wils in Belgium drew my attention to the light curve on the ASAS-SN website where CCD observations confirm similar magnitudes to what I saw.

One doesn't need a 28" to observe variables, but it sure helps and is a pleasure to use. I heartily recommend SDM but there is a bit of a wait at the moment. Rod Stubbings' telescope is also an SDM.

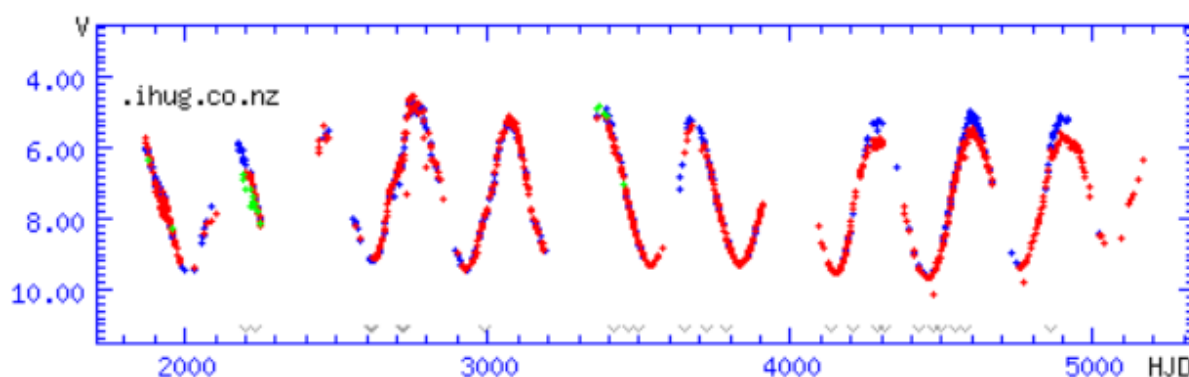
So now, I sit and wait, like so many of you, till the rain stops, till the clouds slide aside and the clarity improves. I welcome visitors. I can always find a spare bed here for the night.

Abstract

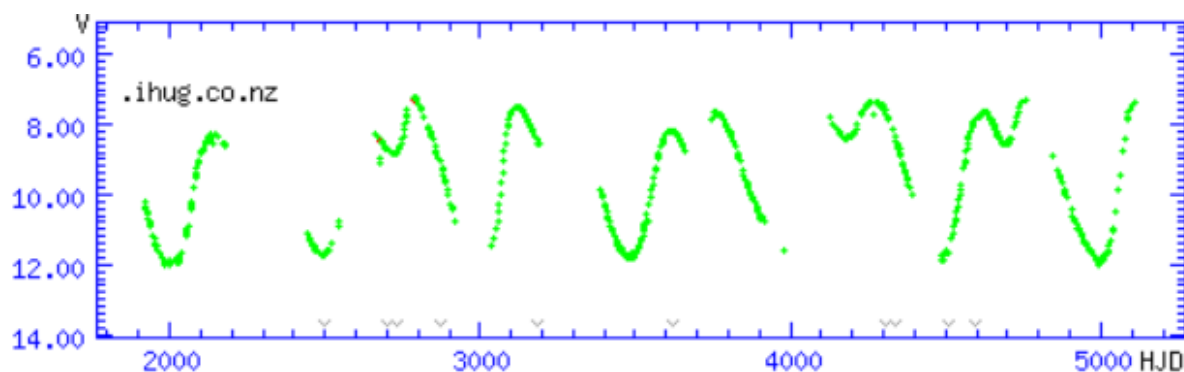
This summary considers methods of extending the scope of the Dual Maxima Mira project to include a variety of objects with similar periods which may be different stages of the evolution of these moderate mass pulsating variables. Three main light curve types are illustrated and possible reasons for these discussed. A list of known and possible DM Miras is presented. Various known aspects of the behaviour of these stars are mentioned and the need to produce accurate colour measures is discussed, as well as observing frequencies and methods.

Introduction

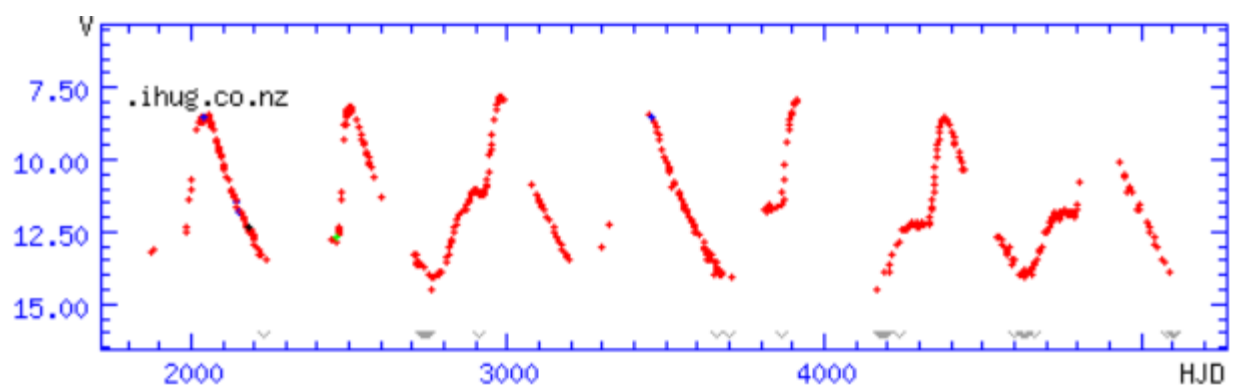
Most Mira stars have simple light curves - a quite smooth rise to maximum and then a decline to minimum. The amplitudes can be as large as ten magnitudes for oxygen rich stars but varies between two and four magnitudes for those with an abundance of carbon in the envelope. A typical light curve, R Carinae based on measures by ASAS3 with a period 307.2 days during this interval, is shown below.



About one to two percent of Miras behave differently. They show a split or dual maximum. This is relatively stable in that it does not disappear except in unusual circumstances. Like all Mira stars, however, the brightness of both maxima can vary, although the intervals between each of the dual maxima are relatively constant and retain the same brightness ratios. A good example is R Normae, period ~500 days during this interval, shown below.



A third group, and this is quite common, comprise those Miras with brightness variations forming a hump, usually on the rise. These are less stable - the humps can disappear and reappear in no predictable manner. The graph below shows R Telescopii, 467 days, with humps on the rising branch.



Structure and shock waves

Mira stars appear to lie in the asymptotic giant branch where they gradually brighten with lengthening periods. They have a multi-shell structure with hydrogen and helium rich shells surrounding an energy producing core. It is believed that the pulsations originate in an outer radiative energy transfer region where hydrogen undergoes ionisation and recombination similar to helium in Cepheids. Surrounding this is a convective envelope which makes the period less regular and also introduces other effects such as an alternating and increasing/decreasing period on a time scale of decades. As evolution proceeds the star expands as it becomes cooler, the overall brightness and structure following the relationship $L = T^4 * R^2$ which it also does during the periodic pulsations.

Models suggest that major period changes are the results of flash burning events in the helium shell at intervals. Associated with these may be changes in the composition of the envelope by a dredge up from lower regions in the star and even more abrupt period increases. These events and period changes are superimposed on the slow evolutionary period increase but the event timescale is probably a millenium or two so has obviously not been fully observed.

The first type of event appears to be associated with the decreasing periods of R Hydrae, R Aquilae and R Centauri, the latter with the dramatic period increases of BH Crucis and LX Cygni. Some evidence of the dredge up effect was noticed by Lloyd-Evans, 1985, who drew attention to a change in the spectrum of BH Crucis from S-C to C-S.

If we accept the concept of travelling up the AGB in the HR diagram then those Miras with long periods should be close to the next evolutionary phase. What is this? It also suggests that this imminent change might be portended by unusual behaviour in the longer period stars - those with periods greater than 400 days. So what unusual behaviour can we identify in such stars? We find:

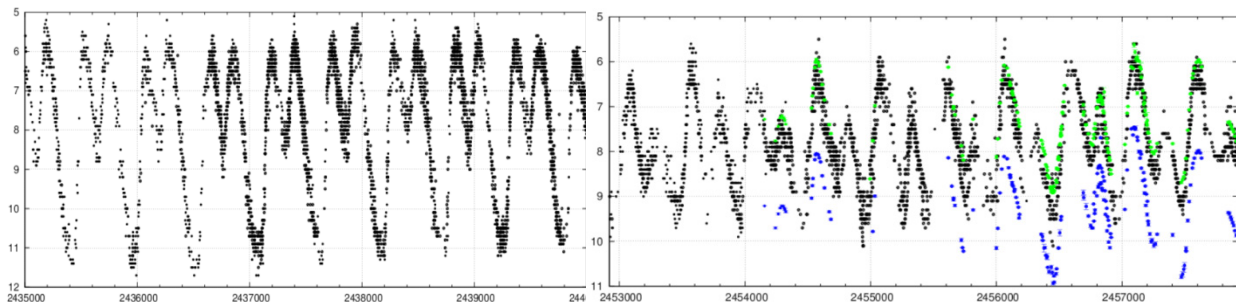
- Two stars with dramatic period increases.
- Perhaps 6 - 10 stars with longer term period decreases
- Stars with humps
- Stars with dual maxima

What do Miras evolve into? Ultimately white dwarfs - but what are the stages between? There are a variety of variable star types in this region, usually with pulsations, but they are all fainter than the top of the AGB where the long period Miras seem to be. If Miras evolve into one or other of these objects what causes the luminosity to decrease?

Dual maxima Miras, also possible and probable candidates

A few years ago the GCVS listed 16457 stars in three similar groups of cool stars with longer periods than Cepheids - Miras 6398, semi-regular 6063 and long period variables 3996. Of the Miras with periods of 400 days or more, 378 are brighter than ~ 16.0 , 167 in the south, 211 in the north. If we use $V = 10.0$ as the limiting magnitude these figure reduce to 33 and 46.

If we're looking in this small sample for specific features how are these defined? R Centauri is a case in point. The illustrations below show two samples of 5000 days each from the International Database separated by 35 years during which time the period decreased by about 5%, the amplitude became less and the shape and amplitude of the second maximum changed dramatically.



Those DMM Miras known or possible at this stage are listed in Table 1. The last two columns are galactic longitude and latitude.

Table 1 Known dual maximum Mira stars and some possible candidates.

Star	R A	Dec	Max	Min	Period	Spectrum	Type	L	B ⁰
V415 Velorum	10 03 30	-46 49.2	9.6	11.8	410~	---	Mira	275.48	6.90
BH Crucis	12 16 17	-56 17.2	6.5	9.8	530:	SC/CS4-8e	Mira	298.04	6.25
R Centauri	14 16 34	-59 54.8	5.8	9.0	500:	M6-8ell	Mira	313.42	1.21
R Normae	15 35 57	-49 30.5	6.4	12.0	507	M3-6ell	Mira	328.32	5.08
BX Carinae	10 52 06	-62 29.0	11.7	13.8	427	---	SRa	289.63	-2.74
TT Centauri	13 19 35	-60 46.7	9.0	13.4	462	CSe	Mira	306.37	1.90
UZ Circini	14 20 52	-67 30.8	9.0	14.0	538	---	Mira	311.35	-6.12
BN Scorpii	17 54 10	-34 20.4	9.7	<15.0	616	---	Mira	356.29	-4.33
FK Puppis	08 07 19	-36 08.3	8.0	9.5	502	C6e N	SR	253.42	-1.78
CK Carinae	10 24 25	-60 11.5	7.2	8.2	525	M3.5lab	SRc	285.61	-2.36
CL Carinae	10 54 00	-61 05.6	8.0	9.0	513	M5lab	SRc	289.22	-1.39
Were once?									
R Hydrae	13 26 58	-23 01.4	3.5	10.9	389	M5-8ell-III	Mira	314.22	38.75
R Aquilae	19 06 22	+08 13.8	6.0	10.2	284.2	M5-9e	Mira	41.95	0.45
Probable									
T Cassiopeia	00 23 14	+55 47.6	6.9	13.0	444.83	M6-9e	Mira	118.95	-6.86
U Canis Minoris	07 38 38	+08 29.6	8.0	14.0	413.88	M4e	Mira	211.02	
New Candidates									
AS143751-6454.9	14 37 51	-64 54.9	12.4	<16	536	J-K = 1.56	Deep sec		
AS Circini	15 13 39	-60 20.3	8.85	10.75	517.9	C	Pos Amp	319.67	-2.17
NSV20070	14 15 50	-58 59.3	10.9	13.2	608		SR??	313.63	
V552 Nor	16 30 13	-53 28.8	10.7	13.2	445	---	SR?	332.04	-3.46
93517-3930.0	09 35 18	-39 30.0	11.6	15.0?	620		Var Hu'p		
KS Pup	07 37 53	-33 29.8	11.8	15.1	400	---	Prob	247.73	-5.87
HR Pup	07 52 58	-20 52.8	11.05	13.3?	509.8	---	SR?	238.46	
65106-1103.1	06 51 06	-11 03.1	11.0?	<15	537		Poss		
RU Tauri	05 52 37	15 58.2	10	<14V	611		Hump	191.98	-5.25

Quite clearly we need to make systematic measures of these stars to decide into which group they fit. So let's look at the observing methods. Before doing this, however, we need to think about the stars themselves. Miras are complex. There is the star itself and the choice of filters determines how deep into its surface we are seeing. They are also emission objects hence the 'e' in the spectrum. Hydrogen alpha

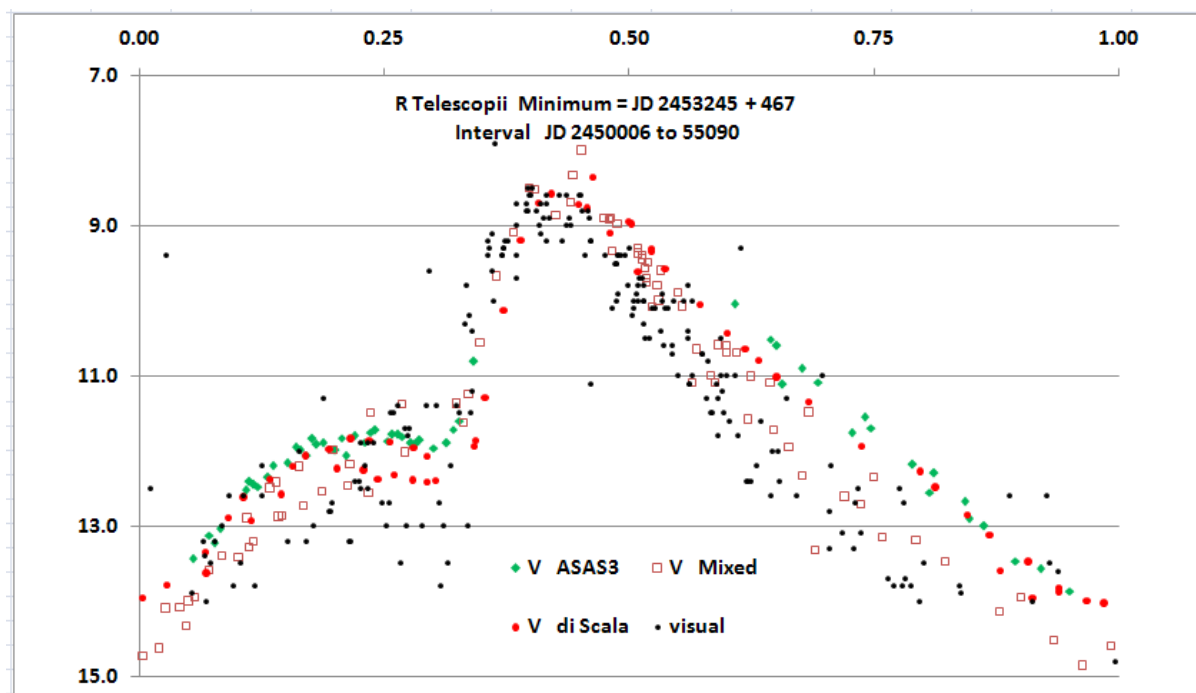
and beta affect the R and B filters but most of the emission is seen in the Balmer discontinuity in the U filter. They have a low surface gravity and material is ejected both by the pulsations and the stellar wind. Close to the star it is a gas with emission lines, farther out it is a cooler dusty region which is visible to some extent in the I filter but more clearly at much longer wavelengths. In some cases such as L² Puppis it forms a cool disc

Observations - visual, UBVRI and other

The overall light curve on a long term basis is best measured visually. It's faster and is accurate enough for most purposes. The eye's response is the standard 'filter' for long period variables. There is little point in V measures alone except when magnitudes are too faint for the eye. But these are best transformed to the standard system so really a two filter system of B and V, or B and R at faint limits, is needed.

Giorgio di Scala has been measuring six or eight Mira stars in BVRI and I am slowly working through these. Due to the brightness in R and I he has used defocussing methods to get good results. One of these, R Telescopii, is discussed elsewhere in this newsletter. This illustrates another requirement - that care must be taken in selecting comparisons. Giorgio is using all sky photometry with accurately measured E and F Region stars as comparisons but it has the drawback that extinction must be taken into account. The alternative is to determine the values of several stars in the field of the variable as sub-standards and carefully measure their values using E and F Region standards or some of the Landolt fields. The E Region stars are a bit scattered and don't go much below V = 10 but John Graham extended these down to V = 14 or 15 and these measures are available on the Internet or on our website.

Let's show one graph of R Telescopii here as a warning. This star has a very pronounced hump on the rising branch and as there are also good BVRI measures from di Scala it was selected for analysis. There are several others destined for similar treatment. A puzzling problem arose which is illustrated in the Excel spread sheet graph below. This shows measures of four different datasets of V or visual measures which are labelled.



What is of concern is the divergence of V measures below magnitude 11. At these fainter levels the measures by di Scala and ASAS3 are still close but the mixed V measures diverge, although remaining similar to the visual values. Some research by Arne Henden suggests that the early V observations, which show the largest divergences, were based on an old sequence the origins of which are not clear. It was certainly not measured at Auckland with other sequences for the RASNZ VSS.

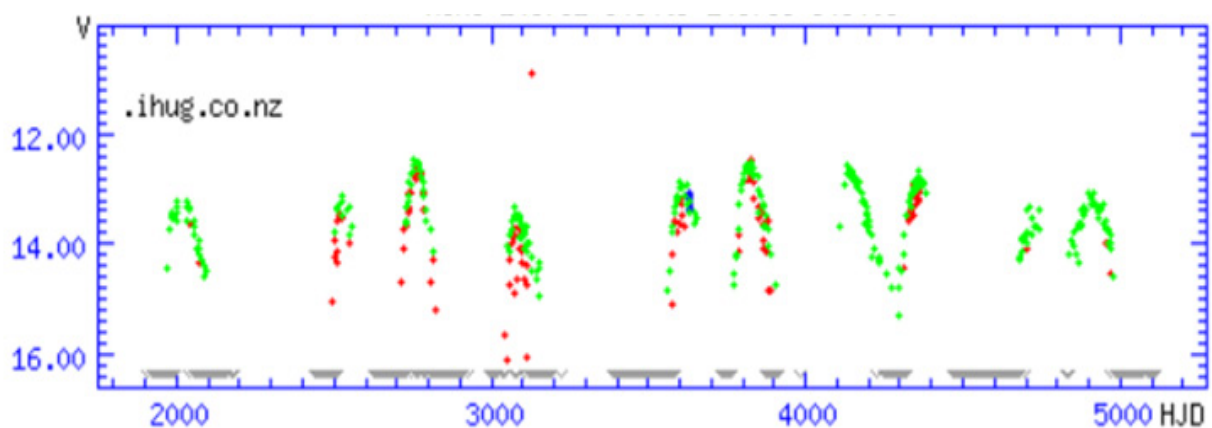
ASAS3 and di Scala both use all sky photometry - the mixed data and the visual measures presumably

use the earlier AAVSO chart and photometry tables or even an old RASNZ VSS chart. The photometry tables were updated in 2013 and the photometry table in this range now seems more reliable. Below magnitude 11 the V measures in the earlier part of the mixed dataset differ by more than a magnitude from the other two datasets. One of the contributing factors is that the conventional presentation method V, B-V, V-R and V-I is not used. An Excel plot of these conventional values will usually highlight any problems.

We need also to provide a base for evolutionary measures. Measures should be made in BVRI during as much of the cycle as possible. Around the two maxima and near the secondary minimum every 5 to 10 days would be very useful - but for the decline and rise from primary minimum measures each 20 to 30 days appear adequate.

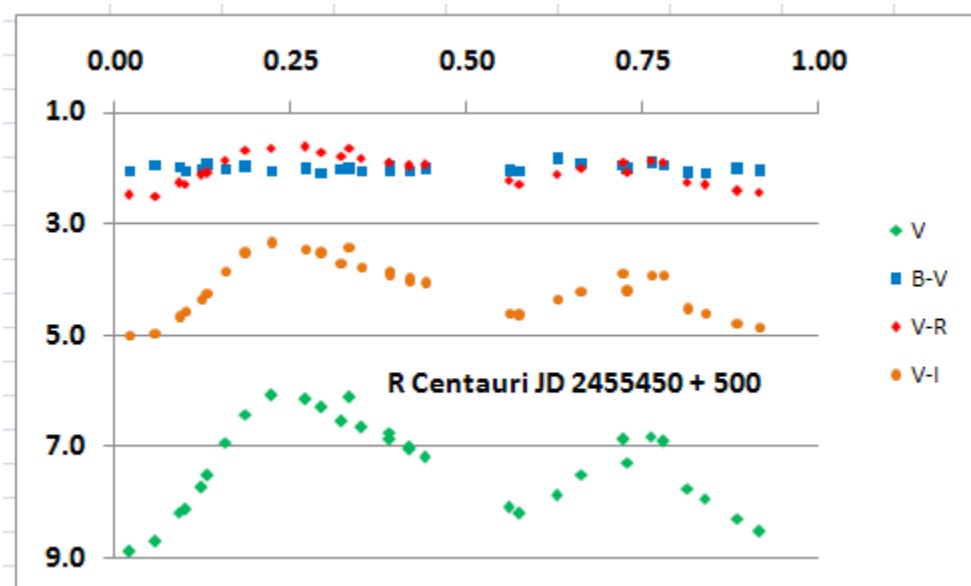
ASAS143751-6454.9

This new object was detected by Sebastian Otero. Little is known about it apart from the ASAS3 measures. The light curve appears below. Like all ASAS JDs 2450000 should be added. There is no real significance in the graph's different colours.



The period during this interval was 536 days and the star is similar to R Centauri as it is now with a deep secondary minimum. The primary minimum may be as low as $V = 18$. The secondary minimum seem to be very low at times, much fainter even than R Centauri in its current state. But without a full light curve we can only speculate. So this star needs close attention and is one of the few where V measures alone at very faint values may be necessary.

Making BVRI measures allows a phased graph like that of R Centauri below to be produced. In all time series measures of pulsating stars to study periods and period changes the V measures define the epochs. This avoids the complication caused by the fact that maximum occurs earlier at shorter wavelengths.



Temperatures are normally determined from well known B-V/temperature relationships. Sometimes V-R or V-I are used for this but it is clear in this graph that both are affected by the star's pulsations. This presents a problem near minimum of fainter stars as B is less sensitive in most CCDs. But if a star is an oxygen dominated Mira the colour changes seem to be much less than in the carbon rich objects so some degree of extrapolation should work.

Some of these stars have companions which may affect the colour curves if they are bright enough. This is best detected using a U filter which provides a reasonable signal if a detector such as a Sony ICX694 or 674 or Kodak KAF3200 is used in your camera. Measuring U-B will also detect emission in the Balmer region from the gas around the star.

Reporting the measures

For this project we would request that all transformed photoelectric measures - CCD, DSLR, PEP - be reported to the project coordinator, Stan Walker, at astroman@paradise.net.nz using the format, JDH (5 digits only preferred), V, U-B, B-V, V-R, V-I, air mass, names of comparison star and check star. Error estimates should be your measured divergence of the observed check star value in V from the catalogue value. Negative if it's brighter. Do not use any other values for this. Shortly you will be able to place these measures directly on the website. Once a month for reporting is adequate.

Results should also be submitted to the International Database maintained by the AAVSO using their preferred format.

Determining comparison and check stars

Some observers prefer all sky photometry which uses a suitable number of stars scattered around the night's target areas and reduces the target stars against these. So these are already available. E & F Region stars are preferable but Landolt stars can be used if desired. Do not use values from the various planetarium type presentations.

The AAVSO list photometry tables with their charts and the few I've checked seem reliable except sometimes at the brighter end. Use only the APASS measures. If these are not available use the method described below. For the stars in Table 1 selected comparison and checks will be available on our website by the end of August. Even if full V, B-V, etc., values are not available the images can be retained and reduced later - a common procedure amongst photometrists.

It is a simple procedure to determine values for in-field sub-standards using E & F Region stars. On a very good night select an E Region on each side of your target field when it's high in the sky. Then select two or three stars of appropriate brightness and colour in each of these fields and your target star field. Then measure E west, Field, E east, Field, E west and repeat. If near the meridian and the target fields are from 30S to 60S and your observatory is not north of 25S extinction will not be a serious problem. Repeat several times at intervals of 20-30 days. You will probably need the Graham extensions to these fields. If you are planning U-B measures then this method is essential for a source of those values.

Some people use ensemble photometry but this is not necessary if the signal is strong enough. If the comparison star is a magnitude or more brighter than the variable it adds nothing to the accuracy and may degrade it. It has value in DSLR photometry as the dynamic range of those cameras is smaller than the normal CCD. For most fields a pair of stars at the bright limit and others at 2 or 3 magnitude intervals is a good method.

Concluding comments

This will be a new field for most and most of my experience is based on the old PEP using a very accurate and sensitive photometry on a very user friendly half-metre telescope. I did some colour photometry using an ST6B CCD camera more recently. So I'd welcome suggestions.

Andrew Pearce with Frank Schorr are featuring many of these stars in the AAVSO LPV section activities but their contributors seem to be mainly visual at present. To be useful UBVR measures need to be expressed in the manner described here and recorded in the same manner.

This is a developing area and no doubt will change as more stars are observed. A reasonably high degree of accuracy is required as comparisons will be made over decades as in the case of BH Crucis. So your calibration methods must be impeccable and for B-V and U-B extinction corrections of both types need to be applied. Contact me if you have any doubts.

Recording eclipsing binary minima – *Tom Richards*

tomprettyhill@gmail.com

Minima and the importance of period change

Recording periodic phenomena, and changes in period, is a fundamental activity in most scientific domains. Period change is often poorly measured if you simply take the time interval between the periodic events, such as the maxima of pulsating variables or the minima (mid-eclipses) of eclipsing binaries. The problems with this method are (a) the uncertainties in the estimates of the periodic event may be significant compared to the period, and so (b) changes in period are easily masked by the errors in event-to-event interval measures.

To overcome this, the *O-C method* is commonly used, and simple. It takes one well-measured event and period estimate, and compares all other event estimates with what that predicts. So if E_0 is the *zero epoch* in astro-speak (time of one well measured minimum, in the case of eclipsing binaries) and P is a period derived from several minima estimates (by linear regression, for example); then we predict the eclipse time T_n occurring n cycles later as:

$$T_n = T_0 + nP$$

The pair T_0 , P are known as the *light elements* for the variable, often called the *ephemeris*.

Comparing that prediction with the observed minima is a simple subtraction: Observed minus Calculated minima times, which yields an easily graphed table of the O-C differences versus cycle numbers n . The plot is not only visually illuminating in that it reveals poor estimates as being out of line; but also its slope and shape instantly reveal subtleties of period change, since the very small changes in P accumulate over time, outweighing individual errors. Figure 1 shows a spectacular example, from the *Atlas of O-C Diagrams of Eclipsing Binary Stars* (Kreiner, 2004).

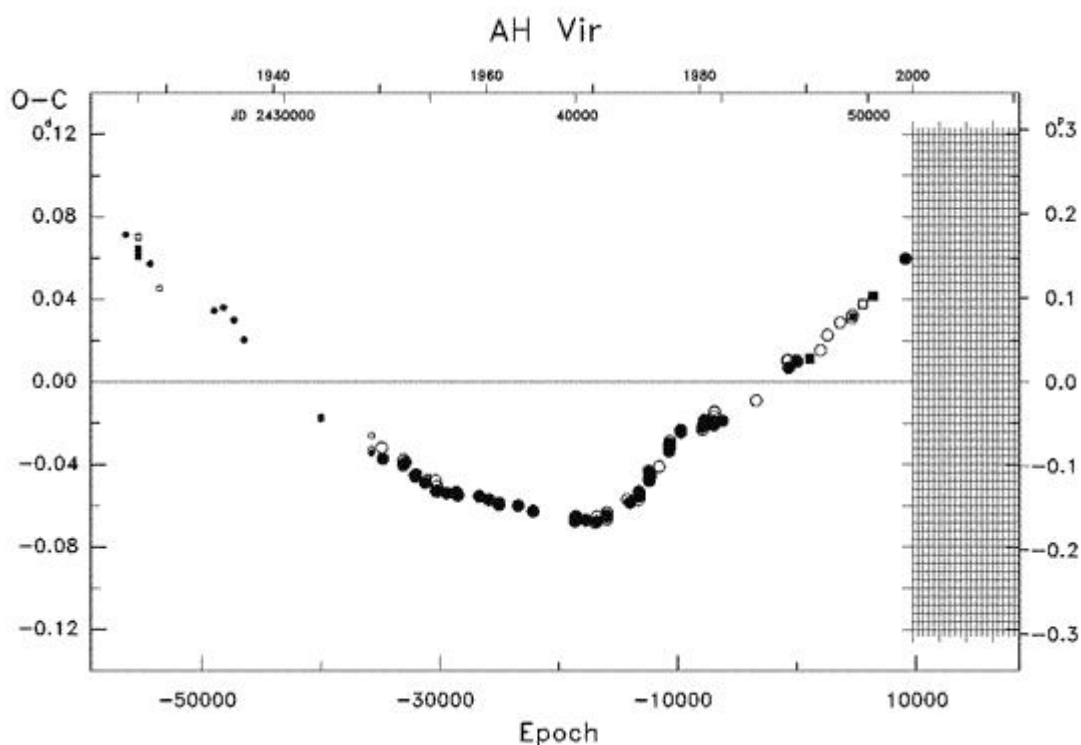


Figure 1. Long-term period changes of AH Vir as shown by an O - C diagram.

If you looked at the linear data in the last third of this diagram from 1980, you'd conclude that since O-C is increasing linearly, the period used in the light elements must be too short. So you could easily calculate from that partial data a longer P that would make that section horizontal. But thanks to many minima estimates over 80 years, such an inference is clearly incorrect. The approximate parabolic shape shows that the *period* is increasing linearly. The light elements would be quadratic, with a positive term in n^2 – fitting an exact calculated parabola to the rough observed one. There is also an interesting hiccup around epoch -10,000, indicating a sudden halt in period change at the point, with the trend increase resuming shortly. What happened to the binary then?

So O-C data, though simply obtained, provide an extraordinarily powerful probe into the astrophysics of close binaries. But the minima estimates need to be obtained frequently and over the long term to give a full picture. That is why amateur observations of eclipsing binary minima (and the vast majority are amateur) are so very useful astrophysically.

Long-term period changes, as with AH Vir, are best explained by mass transfer between the two stars (the period increases if the less massive star is the donor, otherwise P decreases if it's the recipient), or mass loss from the system entirely (P increases). Sudden changes can be explained by a reorganisation of mass inside one star.

The VSS-SEBRG's minima programme

It is no wonder then that a major part of the work of the Southern Eclipsing Binary Research Group of VSS is to obtain minima estimates. The observational method is simple if you have the right equipment – a telescope (or telephoto lens) with camera on a driven equatorial mount. Use available ephemerides to find eclipsing binaries that you can track all night which will have a minimum around midnight. Take images through the night (you can be in bed). Then use available software, some free, to derive a magnitude curve by using a suitable constant comparison star. More software can then derive a minimum estimate from the curve. You can find the details for all of this, with software references, in the VSS-SEBRG sub-web, <http://www.eclipsingbinaries.prettyhill.org/>, or access it from <https://www.variablestarssouth.org/southern-eclipsing-binary-project/> (link at bottom).

Recording and publishing our results

As spelled out on that website, members keep a folder for each star they study in our Dropbox, in which they maintain a spreadsheet <ID> *Minima Analysis.xlsx*. (The template for this is kept in the Downloads section of our sub-web.) In it they enter details about the system, the original light elements from the literature, and their minima estimates. The spreadsheet will automatically calculate:

- Light elements using linear regression from the minima entered;
- Plot of minima times against cycle numbers;
- O-C of the minima from the original light elements;
- An O-C diagram.

In addition, by entering light elements and/or minima from other sources, the observer can manipulate the above functions to prepare much more comprehensive analyses.

Additionally the observer copies their minima to a consolidated spreadsheet *Minima & LEs 2017.xlsx*, holding all minima estimates for all targets by all observers, plus any new light elements. This rather smooth workflow allows me to construct annually a paper of our minima estimates and light elements, which we submit online to the *Open European Journal of Variable Stars*. So far there are two publications, (Richards *et al* 2016, 2017). If you wish to join in on this SEBRG programme, have a read of our sub-web, and contact me. Then you'll have your data (and authorship) in the 2018 paper!

References

Kreiner, J.M. (2004). *Acta Astronomica* 54, 207.

Richards, T., M. Blackford, N. Butterworth, P. Evans, R. Jenkins, 2016. “*Southern Eclipsing Binary Minima and Light Elements, 2015*”. OEJV 177.

Richards, Tom; Blackford, Mark; Bohlsen, Terry; Butterworth, Neil; Lowther, Simon; Jenkins, Robert; Powles, Jonathan, 2017. *Southern Eclipsing Binary Minima and Light Elements in 2016*. OEJV 182.

Software watch

Bob Nelson’s software

Tom Richards is very pleased to announce that all of Dr Bob (RH) Nelson’s astronomy and related software is now exclusively hosted on the Variable Stars South website. It comprises 14 applications (Windows only) and 8 spreadsheets, plus 3 physics applications. To see and download them, go to <https://www.variablestarssouth.org/bob-nelson/>.

Bob says “I am willing and eager to help [VSS members] with the software. I will certainly entertain suggestions for improvement and welcome notifications of any bugs.”

Bob’s software is very widely used in the variable stars community. Here’s a small sample of what’s available - for the rest, see for yourself. There’s going to be something useful for you there.

- **Broadening Functions** - The Rucinski routines to derive RVs from stellar spectra.
- **Minima** - Finds the precise times of minima for eclipsing binary data using 6 methods
- **Astrotime** - A utility that converts epochs, calculates HJD, horizon coordinates, and more. Now does sunrise and set
- **Tom_Cat** - Finds periods for EBs based on times of minima. (It’s hot!!)
- **WDwint** - A front end interface for the Wilson-Devinney star modelling package. This upgrade has additional help and error traps.
- **EB_Elements5e (zip)** - Up-to-date elements and more for more than 8500 eclipsing binaries

Thanks to our webmaster, David O’Driscoll, for prioritising their installation while our website is undergoing reconstruction. And special thanks to Bob for working with VSS to restore this important service to the Internet, after his previous host closed down.

MaximDL CCD v6.14 released

Users of Diffraction Limited’s observatory control program MaximDL CCD will be pleased to note that an update has been released with substantial changes to the autoguiding and AO sections.

the following release notes are from the MaximDL yahoo group.

Guide star detection and evaluation has been improved. Status logging and error reporting has been greatly enhanced both within the Guide Tab and via the Log feature. Guide star SNR is now displayed. In order to make it easier to evaluate changing sky conditions during guiding, Screen Stretch on the guide star window is now forced to Floating once guiding is underway. Calibration now attempts to return the telescope to its original starting location if it is interrupted.

SBIG AO: To better support threading, there is now an SBIG w/AO filter wheel selection; users operating AO must now select that option. Improved auto-dark functionality. Improved star recognition during calibration. Improved progress bar display. Improved tracking speed. Improved shutter management. Added some protection against user configuring with wrong guide camera internal/external setting. User can now enable/disable auto-dark functions.

SBIG Universal: Fixed a problem with STT filter wheels that could cause the next exposure to start before the wheel stopped rotating. Fixed a problem that could leave the STT guide camera shutter in the wrong state. Fixed a problem that could cause unnecessary delays after very short exposures.

ASCOM Camera Interface: Added ReadoutModes support.

Canon: Added support for 5DS, 5DSR, 750D, 760D, 1DXM2, 80D, 1300D, and 800D.

Nikon: Corrected D750 image size.

Convert Color: Added support for Truesense Sparse Color cameras and new DSLR models.

Observatory: Fixed problem with calibration for “Point Telescope Here” function, when calibrating via telescope slews instead of PinPoint.

Screen Stretch: New Floating stretch mode. This is similar to Manual, in that the delta between Minimum and Maximum is kept constant, but if the background level changes the Minimum is adjusted to track it. This new mode is for Autoguiding, as it allows the user to more easily monitor changing sky transparency.

PinPoint: Updated installer to latest release. Fixed a slight offset in center coordinates during telescope sync.

General: Fixed problem with AIRMASS not appearing in the FITS header.

Publications watch

The VSS eclipsing binary group has published another set of light elements and minima of southern eclipsing binaries in the Open European Journal of Variable Stars.

Lead author Tom Richards reports that observers typically made all-night runs on their targets, obtaining hundreds of images for photometric reduction. They analysed the photometry to obtain times of primary and secondary minima. If they obtained four or more minima, including in previous years, they derived light elements (orbital period P and a zero epoch T_0). Additionally, they compared their minima estimates by the O-C method with existing light elements in the literature, sometimes up to a century old, to detect period change.

Other observers who wish to join this team effort are most welcome to contact Tom. Full information about what’s involved in the project can be found at <http://www.eclipsingbinaries.prettyhill.org>.

Richards, T., Blackford, M., Bohlson, T., Butterworth, N., Lowther, S., Jenkins, R., Powles, J. 2016 *Southern eclipsing binary minima and light elements in 2016*. OEJV 182, June 2017.

Abstract: We present 110 minima estimates of 42 southern eclipsing binaries obtained by members of the Southern Eclipsing Binary group of Variable Stars South using DSLR and CCD detectors. Where sufficient minima estimates of a target are obtained, we report the light elements derived from those minima, together with O-C comparisons with light elements in the literature.

Walker, W. S. G., Blackford, M., Butland, R. and Budding, E., Absolute parameters of young stars: QZ Carinae, Mon Not R Astron Soc (2017) 470 (2).

Abstract: New high-resolution spectroscopy and BVR photometry together with literature data on the complex massive quaternary star QZ Car are collected and analysed. Absolute parameters are found as follows. System A: $M_1 = 43 (\pm 3)$, $M_2 = 19 (+3 -7)$, $R_1 = 28 (\pm 2)$, $R_2 = 6 (\pm 2)$, ($\odot$); $T_1 \sim 28\,000$, $T_2 \sim 33\,000$ K; System B: $M_1 = 30 (\pm 3)$, $M_2 = 20 (\pm 3)$, $R_1 = 10 (\pm 0.5)$, $R_2 = 20 (\pm 1)$, ($\odot$); $T_1 \sim 36\,000$, $T_2 \sim 30\,000$ K (model dependent temperatures). The wide system AB: Period = $49.5 (\pm 1)$ yr, Epochs, conjunction = $1984.8 (\pm 1)$, periastron = $2005.3 (\pm 3)$ yr, mean separation = $65 (\pm 3)$, (au); orbital inclination = $85 (+5 -15)$ deg, photometric distance $\sim 2700 (\pm 300)$ pc, age = $4 (\pm 1)$ Myr. Other new contributions concern: (a) analysis of the timing of minima differences (O – C)s for the eclipsing binary (System B); (b) the width of the eclipses, pointing to relatively large effects of radiation pressure; (c) inferences from the rotational widths of lines for both Systems A and B; and (d) implications for theoretical models of early-type stars. While feeling greater confidence on the quaternary’s general parametrization, observational complications arising from strong wind interactions or other, unclear, causes still inhibit precision and call for continued multiwavelength observations. Our high-inclination value for the AB system helps to explain failures to resolve the wide binary in the previous years. The derived young age independently confirms membership of QZ Car to the open cluster Collinder 228.

About

Variable Stars South is an international association of astronomers, mainly amateur, interested in re-searching 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.VariableStars-South.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

Webmaster David O’Driscoll

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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