British Astronomical Association

VARIABLE STAR SECTION CIRCULAR

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Contents

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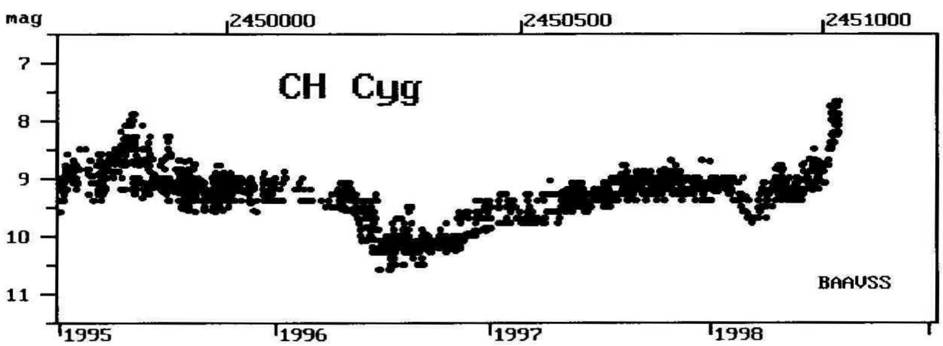
VARIABLE STAR SECTION MEETING

ROGER PICKARD

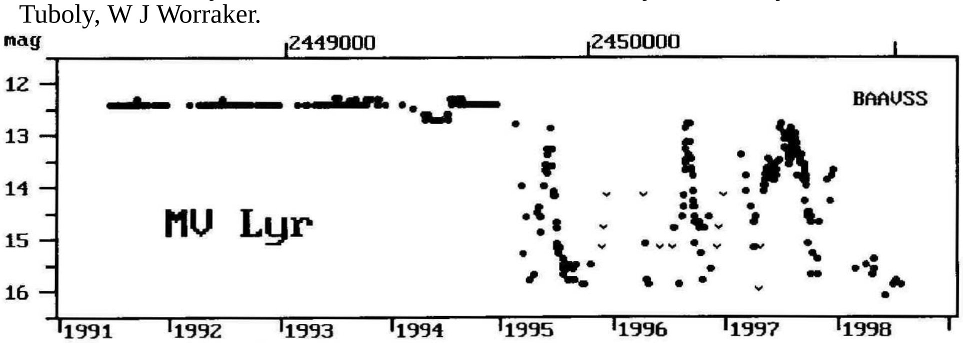
The Crayford Manor House Astronomical Society will be hosting the next Variable Star Section Meeting on October 31st 1998. Details are yet to be finalised, but it is expected that the doors will open at 10 a.m., and the meeting should finish around 5.30 p.m. A buffet lunch will be available for a small charge, and this can be booked on the day. If anyone requires further information, or wishes to give a talk, or exhibit material, then please contact Roger Pickard (address and e-mail are given on the back cover) or visit the Variable Star Section web page for regularly updated information (see address on the back of this circular).

LIGHT CURVES

DAVE MCADAM



CH Cyg 1995 to 1998. 1964 observations by:
S W Albrighton, K G Andersson, A R Baransky, N M Bone, R J Bouma,L K Brundle, J S Day, R B I Fraser, D Gavine, D Gill, B H Granslo, C Henshaw, G M Hurst, Miroslav Komorous, D K Lloyd, T Markham, H W McGee, J Meacham, Volodymir G Mormyl, I P Nartowicz, B O'Halloran, G Poyner, J D Shanklin, D M Swain, M D Taylor, D R Taylor, J Toone, Vince Tuboly, W J Worraker.



MV Lyr 1991 to 1998. 662 observations by:
K G Andersson, R J Bouma, J S Day, G Poyner, M Westlund, W J Worraker.

RECURRENT OBJECTS PROGRAMME

GARY POYNER

A recent review of the Recurrent Objects Programme has resulted in a series of changes to the objects which are currently being monitored. The following notes give details of stars which have now been dropped from the programme, and lists those which are to be added. The stars which have been dropped will still be included in the telescopic programme, and should continue to be observed. They will, however, no longer be regarded as alert stars. These changes take effect immediately. It should be remembered that the Recurrent Objects Programme was set up to monitor poorly studied CVs, whose period of outburst (if known at all) is greater than one year, and whose details of amplitude are very limited or completely unknown.

Stars dropped from the programme:

AK Cnc

12 confirmed outbursts have been detected by ROP observers since 1992 (Dec 92, Nov 93, Feb 94, Apr 94, Mar 95, May 95, Oct 95, Jan 96, May 96, Nov 96, Apr 97, Feb 98). Superhumps of an amplitude of 0.18 magnitude were detected for the first time by observers at Ouda Station, Kyoto University on January 13, 1992, thus identifying AK Cnc as a UGSU type star.

TV CrV

3 outbursts have been observed (Jun 94, Apr 95, Apr 97) none of which were observed from the UK. Superhumps were detected during the 1994 outburst (Kyoto University) which led to the UGSU classification.

W Com

2 major outbursts were detected in 1995 and 1998, but it has remained in a high state (above magnitude 15) since 1995. It is difficult to continue to classify this star as a recurrent object.

CI Aql

IBVS 4232 shows that CI Aql is in fact an Eclipsing Binary with a small amplitude. The 1917 outburst remains a mystery.

DM Lyr

14 confirmed outbursts have been observed since 1992. Both normal and superoutbursts have now been observed (Jly 92, Sep 92, May 94, Jly 94, Sep 94, Feb 95, Nov 95, Jly 96, Feb 97,May 97, Aug 97, Nov 97, Mar 98, Jly 98).

V795 Cyg

6 outbursts have been observed since 1992. No superhumps have been detected during any outburst. UGSS classification remains. Several outbursts have probably been missed during late winter periods (Nov 92, Nov 93, Aug 94, May 95, Apr 97, Mar 98).

V1028 Cyg

6 outbursts have been detected since 1992. UGSU type was confirmed during the July 1995 outburst (Sep 92, Nov 92, Jly 95, Aug 96, May 97, Nov 97).

V632 Cyg

10 outbursts have been observed since 1993. No superhumps were detected (Nov 93, Jly 94, Oct 94, Mar 95, Oct 95, May 96, Oct 96, Nov 96, Jly 97, Dec 97).

DX And

6 outbursts have been observed since 1992. UGSS classification remains. Probably at least two outbursts have been missed during this period when the field lies low in the north during early Spring (Feb 92, Aug 93, Sep 94, Jun 95, Feb 96, Dec 96).

Stars to be added:

Var 61 Her

Discovered by Antipin. (See IBVS 4578) 18h 05m 46.4 +31 40'18" (2000.0) Type UG? Range 13.5B - <18.0

V660 Her

This was seen to undergo an outburst on July 6 1995, resembling a superoutburst (As. Ap. Sup. 130, 485). 17h 42m 09.19 +23 48'30" (2000.0) Type UGSU? Range 14.2V - 19.0p

V358 Lyr

On Steve Howell's suspected TOAD list. No previous known visual outbursts. 18h 59m 34s +42 24'14" (2000.0) Type UGWZ? Range 16p - <20.0p

USNO 1425.09823278

Just the one outburst in 1997, which turned out to be a superoutburst. 19h 27.2m +54 18' (2000.0) Type UGSU, Range 13.3 - 19.9R

Var 62 And

Discovered by Antipin (see IBVS 4578) 00h 11m 07.3 +30 32'36" (2000.0) Type UG, Range 15.5B - <17.8

NEW BAA COMPARISON SEQUENCES FOR IP PEG

BILL WORRAKER

The plan to introduce a BAAVSS web page on IP Peg prompted requests for a new comparison sequence based on reliable photometry.

High-quality professional V-band photometry on the IP Peg field has recently been undertaken and published by Skiff [1] and by Misselt [2]. Both authors use the Landolt system of photometry, so resulting V-magnitudes should be directly comparable. Stars B, C, 1, D of the old TA sequence (listed as GMH940130) are covered by both, the maximum difference in V being less than 0.03 mag (for star 1). Thus we have produced a new sequence of V magnitudes based directly on the Skiff and Misselt results, Skiff's figures being chosen for B,C, 1, and D since his statistical uncertainties are generally smaller than Misselt's. These magnitudes should be suitable for observers using CCDs with appropriate V-filtering.

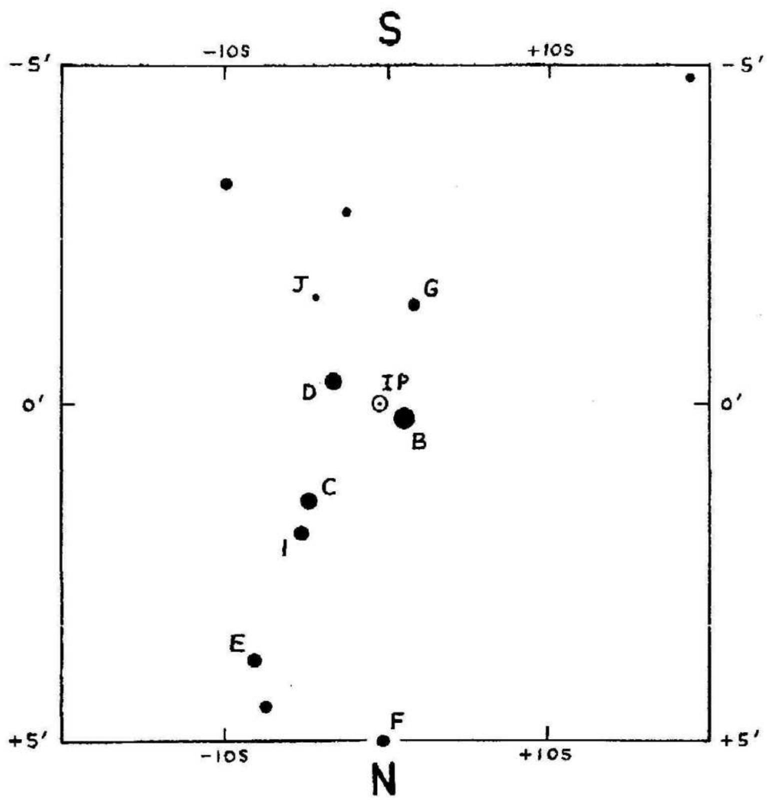
Although it is common practice to use V-magnitudes directly for visual work (generally because no other useful photometric data is available), the colour response of the human eye, especially when fully dark-adapted, approximates to a combination of B and V. This problem has been investigated by Howarth and Bailey [3], who recommend the formula mv = V + 0.16(B-V) as a good approximation to the *average* state of dark adaptation of the average human eye; their formula gives better results than pure V-magnitudes for visual work [3,4], so we have used it to produce a new visual magnitude sequence for IP Peg based on instrumental photometry. The necessary values of B-V have been taken from Misselt [2] where possible (stars B, C, 1,D, G and J), from Goranskij et al [5] for star F, and estimated from b-y values from Skiff [1] in other cases (stars A and E; b and y are the Stromgren blue and yellow filtered magnitudes respectively). Note that visual magnitudes appear fainter than V, which is a direct consequence of positive B-V values. B-V is positive for the large majority of stars in the Galaxy.

References

1. B.A. Skiff, 'Skiff on IP Peg', submission to VSNET dated 10th Oct 1994.
2. K.A. Misselt, PASP 108, pp.146-165, 1996.
3. I.D. Howarth & J. Bailey, JBAA 90, pp.265-272, 1980.
4. T. Brelstaff, C. Lloyd, T. Markham & D. McAdam, JBAA 107, pp.135-140, 1997.
5. V.P. Goranskij, S.Yu. Shugarov, E.I. Orlowsky & V.Yu. Rahimov, IBVS 2653, 1985.

186·02 10′ FIELD INVERTED

IP PEGASI $23^{H} 23^{M} 7.2^{S}$ $+18° 25' 10''$ (2000)



SEQUENCE:
V MAGS A-F B.SKIFF,
G & J K.A. MISSELT.
mv CONVERSION APPLIED BY
W.J. WORRAKER FROM HOWARTH
& BAILEY JBAA 90,180.

CHART:
FROM GUIDE 6.0

	mv	V
B	11·1	10·99
C	12·7	12·55
D	12·8	12·72
I	12·9	12·81
E	13·0	12·94
F	13·8	13·67
G	14·1	13·89
J	15·7	15·58

BAA VSS
EPOCH : 2000
DRAWN : JT 1-8-98
APPROVED: G. Poyner 4-8-98

IMPORTANT NOTE:

VISUAL OBSERVERS SHOULD USE THE mv SEQUENCE ONLY. THE V SEQUENCE IS FOR PEP OR CCD USERS WORKING IN THE V BAND (THE RESPONSE OF UNFILTERED CCD'S WILL NOT MATCH THIS SEQUENCE).

KEELE COLLABORATION - UPDATE

Bill Worraker

In a recent telephone conversation with Dr Tim Naylor (Director, Keele Observatory) I discussed the progress to date and future plans for Pro-Am collaborative work on eclipsing dwarf novae.

IP PEG

A paper on the 1997 September outburst is shortly to be submitted to MNRAS for publication. Eclipse observations made during this outburst, which was characterised by a slow rise (~4 days), have shown it to be of 'inside-out' type.

The focus of professional interest is now on:

- obtaining the equivalent coverage of a fast-rise outburst to see whether or not it is of 'outside-in' type as theory predicts. In order to speed up early detection and reporting procedures, Tim noted that he would encourage reliable, experienced observers to contact him directly on suspicion of seeing the start of an outburst even if confirmation has not been obtained (preferably after first checking the orbital phase to ensure that it is not merely the quiescent orbital hump which is being seen). He also suggested exchanging phone numbers with a couple of Americans with whom he is in contact so that alerts and confirmation can be achieved more quickly than at present. Tim is now setting this up.
- the second emerging interest is in observing eclipses of IP Peg when it is *declining* from outburst. The exact planning of intensive coverage for such an exercise can be left until an outburst is established. Overall, it is clear that the work on IP Peg is producing interesting results and that there is an ongoing need for general coverage, early detection of outbursts and eclipse coverage during outbursts.

For more information on making eclipse observations of IP Peg see the variable star web page (URL on back cover of this issue).

HT CAS

A paper on the 1995 November outburst is almost ready to go to MNRAS for publication. Apparently there is no great professional interest in a superoutburst of this star as superoutbursts of other eclipsing SU UMa stars have previously been published. However Tim would still like to be phoned if it goes into outburst. My own view is that this should continue to rate as a high-priority object for amateurs (DV UMa too) even if current professional interest is limited. That interest could well revive in future, and then the value of amateur records of outbursts etc will once again be seen.

EM CYG

The 1997/98 coverage has shown that this is a true Z Cam star. Its several outbursts in 1997 and early 1998 have established a short outburst cycle length in the region of 20 days, and it is currently in standstill (since mid-June 1998). These results clearly indicate that its Z Cam classification is correct. Les Thomas' project is continuing and Tim urges continuing coverage, both in terms of its long-term light curve and eclipses, whatever its outburst state.

SUMMARY OF VARIABLE STAR SECTION OFFICERS MEETING HELD ON NOVEMBER 23RD 1997

ROGER PICKARD

REPORTING OBSERVATIONS

As described in the last Circular, all observations should now be sent to Dave McAdam as sole Section Secretary, with Melvyn acting as Assistant Director, allowing him more time to concentrate on binocular observers and observations. Observations should be sent at least six monthly, as at present, but in future more frequent reporting is to be encouraged (especially by e-mail) and ideally, paper observations could be sent three monthly. Novae and Supernovae observations should continue to be sent to Guy Hurst on a monthly basis, at least, as at present. Observers should be encouraged to report times in UT not GMAT, but should still indicate which system they are using. All new observers should be encouraged to use UT only! The report form would not be changed for the present. All observers should be encouraged to enter their own observations onto a PC and report in this format, by e-mail where possible. All observations will be acknowledged by Dave. Dave reported several puzzling gaps in the paper records of the archive. He cited R CrB as an example where observations for 1905-1920 were missing, but the star *must* have been well observed in those missing years.

MIKE COLLIN'S STAR DISCOVERIES

These were still poorly observed. It was felt observations of these stars should be encouraged as they were a British discovery, and as such needed following up by British observers. It was agreed that it would help if charts were printed in future circulars, and to this end the first would be printed in the March 1998 Circular. Further charts would be printed on a regular basis in subsequent circulars.

Roger reported that work was being done at Crayford on the Archive. This included requests for observations via TA, as well as requests from professional astronomers (usually Chris Lloyd at the Rutherford Appleton Laboratory). In addition to this, it was intended that some of Mike Collin's stars should be followed up, and work had already commenced on this.

PHOTOELECTRIC PHOTOMETRY

John said PEP sequences are required for a number of binocular stars, and that this is something that Kevin West should also be encouraged to do. A list of stars with poor sequences would appear in the December circular.

CCD PHOTOMETRY

It was generally agreed that CCD photometry could not yet be relied upon to give good magnitude determinations. There was a lengthy discussion on CCD observations and the generally poor results obtained. From results submitted to date it would seem that John Mackey and Nick James were the only CCD observers submitting results in the UK. Karen reported that V and R filters were now available in the US that were exactly the same as those she had decided to use, and she had bought a set. They were also the same as those recommended in the Instruments and Imaging Newsletter. There then followed a discussion on follow-up observations of supernovae discoveries and the fact that there were so very few!

INTERNATIONAL VARIABLE STAR SEQUENCES

It was generally agreed that the proposal by Dick Chambers that was recently submitted to Janet Mattei of the AAVSO was a good idea, but other organisations would need to agree to it. A reply was awaited from Janet.

PROCEDURES FOR VARIABLE STAR DISCOVERY CLAIMS

Guy reported on the recent false alarms that had appeared on the Internet. He then described the follow-up procedure that had now been adopted following the insistence of Brian Marsden at CBAT. (See TA Vol. 34 No 402 for 1997 October for a full report on this). It was stressed that the TA team were still held in high regard by Brian Marsden and it was not TA's methods that were in question. However, it was believed some Japanese were still insisting on publishing all observations, be they confirmed or not! Guy said he now only sent queries to selected observers for checking.

UK NOVA/SUPERNOVA PATROL

Guy reported an increase in the numbers of people undertaking patrols following the three recent supernova discoveries. He also said he was encouraging people to undertake photometry and astrometry. It was noted that very few, if any, novae were now being discovered due to the increased use of CCDs with their small fields.

CIRCULARS CONTRIBUTIONS AND FEEDBACK

Karen said she did not receive many letters, but nonetheless it was agreed those received should be published if of sufficient interest, and if agreement was given by the author. To this end a Letters Page should be instigated in the Circulars. Dave asked if the BAAVSS Web page address should be added to the Circulars and if it was acceptable for articles to be added to the web page from the Circulars. This was agreed, although it was stated that authors should first be contacted for their approval. Dave confirmed that he had already done this for the articles that had already appeared on the web page. John said interim reports should be included where the material called for it i.e. light curves and related notes. John also said it would be nice to see "observer profiles" in the Circulars along the lines that Tristram used to do for the "Variable Star Observer". Tristram said he will see if he can do this again. It was agreed that pictures should also be included now that scanners were more readily available.

UPDATE ON VSS LEAFLETS

Gary is trying to get the section leaflets into a small book format and have a number printed. It was anticipated that funds for this will come from the BAA, not Section expenses!

CHARTS

Once a chart is approved by Gary it should be sent to Hazel McGee for scanning and posting to the VSS Web page. Gary proposed that new charts should include more information on the variable star itself although John was strongly opposed to this and much discussion ensued. John was concerned that observers could be biased by adding range, period etc to the chart and that such a move would undo the good progress made recently on chart form and standardisation. The others felt that there was a need to provide observers with the additional information. Subsequently, a further meeting was arranged to resolve the issue where it was agreed that the existing chart format will be retained. However, new charts and newly updated charts will include a separate data sheet providing additional useful information. This will be for a trial period of 12 months

NEW OBSERVERS

John suggested sending a copy of the Circular to each Astronomical Society with a covering letter. Tristram suggested the booklet Gary is producing would be better. Karen felt a discussion on why stars vary would help, as would a leaflet on the types of variable star and the usefulness of observations. Dave suggested a note about what has been learnt from VS observations i.e. the shape of the galaxy, etc.

DOES THE INTERNET BIAS OBSERVERS?

Guy was worried that observations reported on the Internet can bias one's own. For example, he had noted that if one observer reported a drop in magnitude others would follow even if there wasn't one!

AOB

John asked for suggestions for "Variable Star of the Year" for the Handbook. Gary suggested SS Cyg but this would be two charts and there was only space for one. RZ Cas was finally agreed on and Tristram will see what he can produce. Roger offered assistance in producing a list of times of minimum. Tristram added that the chart may need updating and John will do this.

POSSIBLE RECURRENT NOVAE IN M31

TRISTRAM BRELSTAFF

In a paper describing work by the GCVS team on improving the positions of extragalactic variables listed in Volume V of the General Catalogue of Variable Stars (Proceedings of the 29th conference on Variable Star Research, 7th-9th November, Brno, Czech Republic, pages 107-110, 1998), V. P. Goranskij mentions the identification of the following two possible recurrent novae in the Andromeda Galaxy:

Nova Hubble No 62 (1926) = Nova Rosino No 39 (1962)
Nova Hubble No 35 (1924) = Nova Bryan (1987)

These were picked out during the construction of cross-identification lists. The positions of the Hubble and Bryan novae are only approximate, but as both fields are in the outer parts of the galaxy, the probability of pairs of novae occuring so close together is quite small. Accurate astrometry of the original images should be able to confirm the recurrent nature of these objects.

REQUEST FOR SPARE BACK ISSUES

KAREN HOLLAND

I would like to complete my collection of Variable Star Circulars, but I am missing several issues. If anyone has a spare copy of any of the following VSSCs that they would not mind parting with, please could they let me know:
any issues pre 53 or issues numbered 61, 64, 68 to 71 inclusive, 73, 74 and 81

CONCEPTS OF FILTERED PHOTOMETRY - PART 1

GRAHAM SALMON

Introduction

The enormous amount of data built up by the traditional method of visual photometry demonstrates that this is an effective method of measuring the light output of a variable star. However, like every system, it has its limitations, particularly in the accuracy which can be achieved (even with the most skilled observer) and the lack of any reference to a change of colour index.

The Light Output of a Star

We are all familiar with the way an object, when heated, passes through the stages of dull red, then cherry red to white hot. Our eyes are only sensitive to a very small part of the whole electro-magnetic spectrum and, even with a large telescope, they are barely sensitive to colour at the very low levels at which they operate with stars.

If the complete spectrum of a body at a temperature of 30,000K is measured and plotted, a curve is produced as in Fig.1 which stretches all the way from X-rays to radio waves. It reaches a peak at a frequency of 5×10^{15} Hz, drops sharply at higher frequencies and much more gently at lower ones. The output across the visual band from red to blue is a very small part of the whole but is almost level, so we call it 'white hot'. The curve for a body at 3000K, the temperature of a red giant, is also shown. The shape of the curve remains more or less the same, but the peak frequency is proportional to the temperature. This is Wien's displacement law.

Therefore, if we want to know the temperature of a star, we need to plot its output across the spectrum.

We would use a collimator, slit, prism and CCD to measure the light collected at each point of the spectrum. However, this would spread the light over a large area and would require a much longer exposure for the star. This would severely limit the stars attempted to brighter ones.

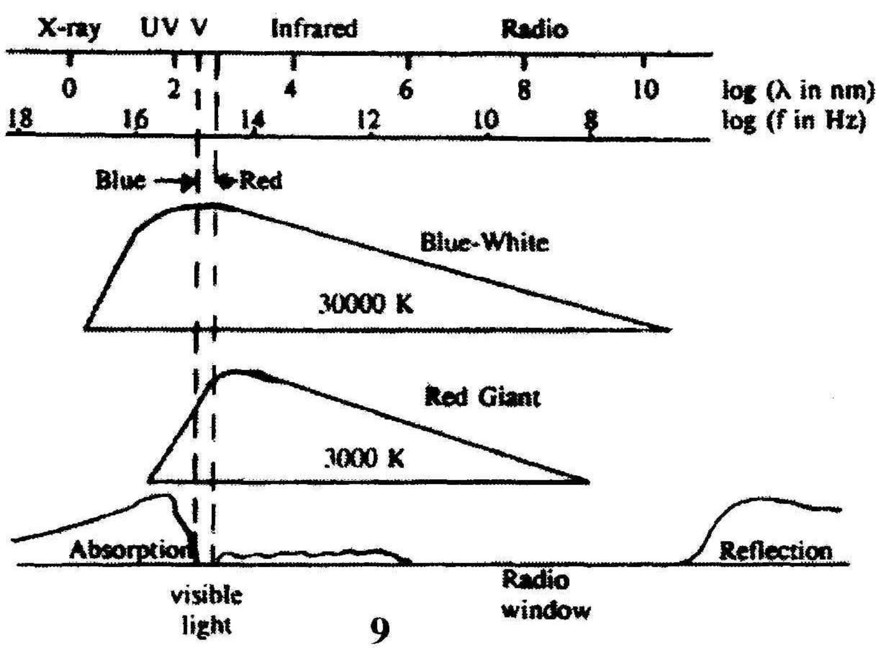


Figure 1

Colour Indices

We do not need such detail. We can have a measure of the general shape of the spectrum of a star by sampling it using ‘broad band’ filters. The spectrum from the UV to the IR can be divided into five under a system known as Kron-Cousins, and ideally each filter would have a similar transmission characteristic as shown in Fig 2.

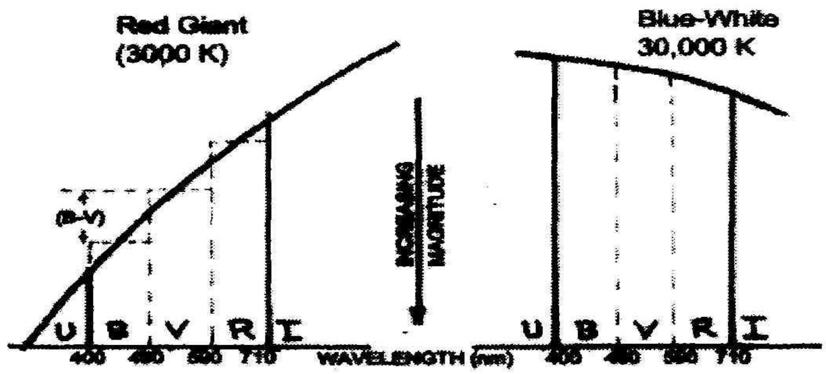


Figure 2

For each star, the difference between the adjacent bands (B-V), (V-R) etc., will provide a measure of the slope of the curve over that part of the spectrum, and hence an indication of the colour balance and temperature.

These are called the Colour Indices. (B-V), the most commonly quoted parameter, ranges in main sequence stars from -0.4 for a blue-white star to >1.5 for a red giant. (As magnitudes increase as the star is fainter, these values go in the opposite direction to first expectations!) The ‘colour temperature’ derived in this way is that which a ‘black body’ (or perfect radiator) would have with this colour index. However, it should be remembered that the constituent elements and physical processes in the star will distort the pattern of radiation, so it will be somewhat different from the effective temperature . However, ‘colour temperature’ is still a useful concept.

A Filter System

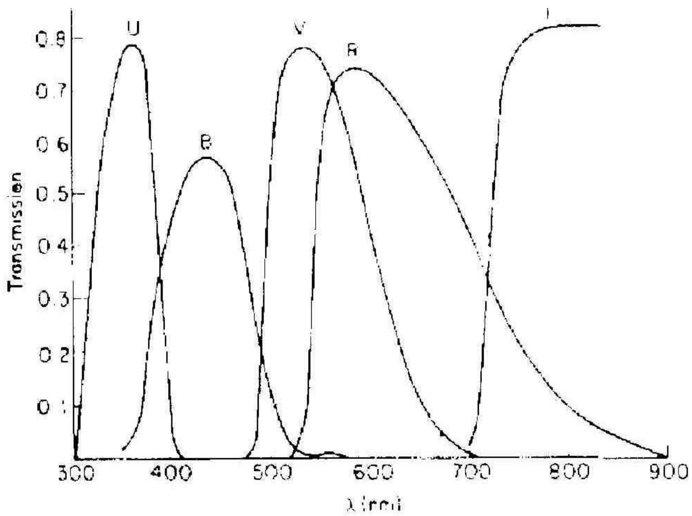
The CCD has the useful characteristic that the charge generated in each pixel is closely proportional to the light falling on it. The software supplied with CCDs usually has a facility for measuring this. The CCD also enables simultaneous observation of the variable and comparison stars which come within its field of view (which is not the case with photomultiplier tubes).

As most of us have to be content with one telescope and one CCD, the four or five filters on it need to be mounted so that they can be changed easily, ie. on a rotary or slide carrier, and the method of measurement has to take account of the fact that the exposures are then taken in succession rather than simultaneously, so that the sky conditions may well have changed from one frame to the next.

The frames will show the variable (V) and comparison stars (1,2,3 etc) some of which will be brighter in the blue and UV, and others brighter in the red and IR. After pre-processing, suitable software can measure the brightness of the variable and each comparison star on each frame (U, B, V, R and I), and express it as a magnitude.

Actual filters are made of coloured glass and have a response as in Fig.3 - peaking at some central frequency and dying away on each side, overlapping into the area of the adjacent filter. To complicate matters further, the CCD also varies in its response as in Fig.4, with substantial differences between different types of CCD.

Figure 3



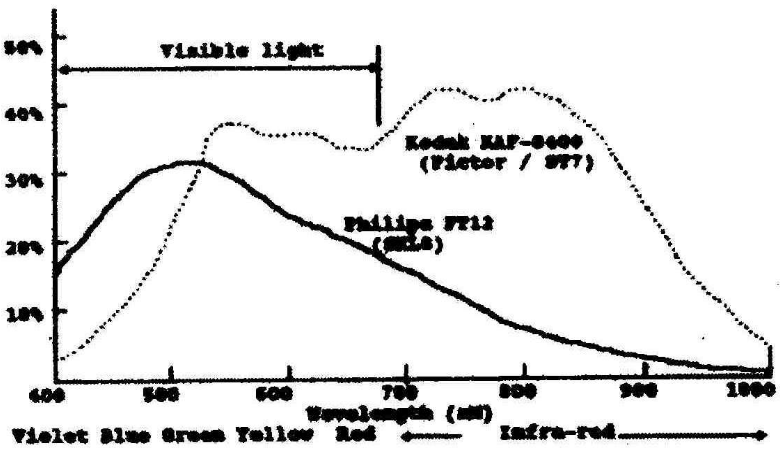


Figure 4

So the magnitude read by the computer off the CCD frame will depend on the intrinsic brightness and colour index of the star, the sky conditions, the telescope and filter, and the CCD. Before proper observations can begin, the system has to be calibrated.

Callibration

We require a set of factors known as Transfer Coefficients, which we can apply to actual observations to correct for the characteristics of the system.

To determine these factors, we need to use a group of standard stars which vary in colour index, but can all be included on one frame and whose UBVRI magnitudes have been carefully measured. The group most frequently used is in the open cluster M67 and consists of eight stars ranging from red to blue-white. Exposures are taken through each filter in turn, and then, after pre-processing, the photometry is done on each frame and the results are recorded.

There are two types of coefficient:-

a. For each individual filter - a factor is required which relates the way the sensitivity of the system varies with the colour index of the star, ie. if, as in Fig.5, two stars have the same total output between green and yellow, but differently distributed, how does the instrumental magnitude vary? For each frame, the difference between the standard and instrumental

magnitudes of each of the eight stars is plotted against their respective colour index as in Fig.6, and the best fitting slope determined. These Transformation Coefficients are known as *tu*, *tb*, *tv*, *tr* and *ti*.
The slope should be around '0', ie. the the instrumental magnitude relative to its standard value should not change much, if at all, with colour index.

b. For each pair of adjacent filters - a factor is required which relates the way the relative sensitivity varies with colour index of the star.
For each frame, the instrumental colour index of each of the eight stars is plotted against their respective standard colour index as in Fig.7, and the best fitting slope determined.
The Transformation Coefficients are the inverse of these slopes and are known as *tub*, *tbv*, *tvr* and *tri*. Their value should be around '1', but will probably be somewhat greater, ie. the sensitivity when using the B filter is less than when using the V filter (mostly due to the CCD) so that subsequently, when using the system for actual measurement, b values will have to be increased by say 1.5 to get the true values.
In practice, only some of these coefficients are required, depending on circumstances. For instance, if one was only using the B, V and R filters, the V measurements would form the base and require the tv coefficient, while the B and R measurements would be made relative to this and just require the coefficients tbv and tvr.

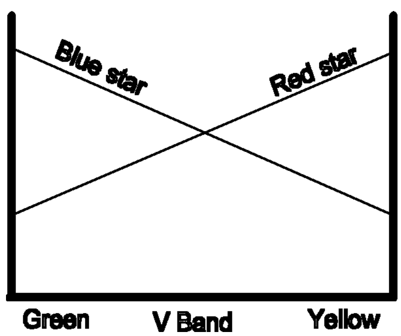


Figure 5

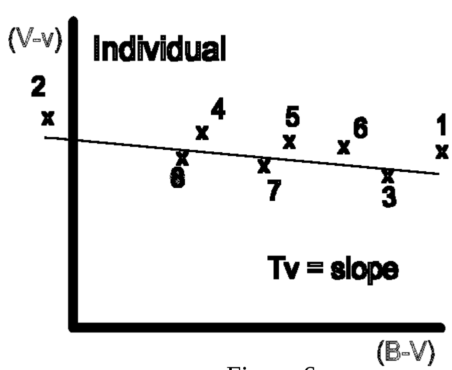


Figure 6

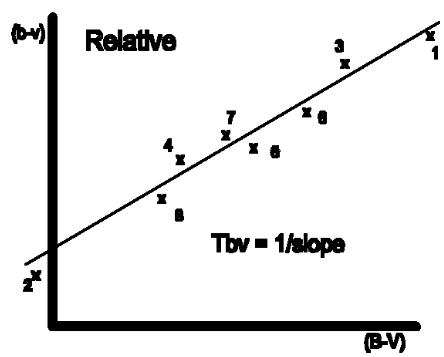


Figure 7

Extinction Coefficients

These must be mentioned, if not elaborated upon, at this stage. As we all know, the sun is redder when rising and setting because of the greater depth of atmosphere through which the light passes compared to when it is overhead. This means that the atmosphere absorbs much more blue light than red. The same thing happens to starlight even though this is not noticeable to the naked eye. Therefore, when making observations for photometric purposes, the altitude must be noted and an Extinction Coefficient applied to allow for this. When applied it corrects the magnitude to the value it would have if the observation had been made above the atmosphere.

Fig.8 shows this for a flat earth which is acceptable for us as long as the altitude of the star is >30°. The depth of the atmosphere through which the light must pass is called the Air Mass and, relative to the distance when it is overhead, is equal to Sec Z, the zenith angle, or Cosec Alt.

If a close pair of stars, one red and one blue, is observed rising from near the horizon to the meridian, their magnitudes determined and corrected with the transfer coefficients, and then plotted against their respective air mass as in Fig.9, two lines will be produced, one for the red star and one for the blue. These can be extrapolated to the vertical axis to derive the magnitudes that would have been measured if it had been done above the atmosphere. The extinction coefficients can be derived from this.

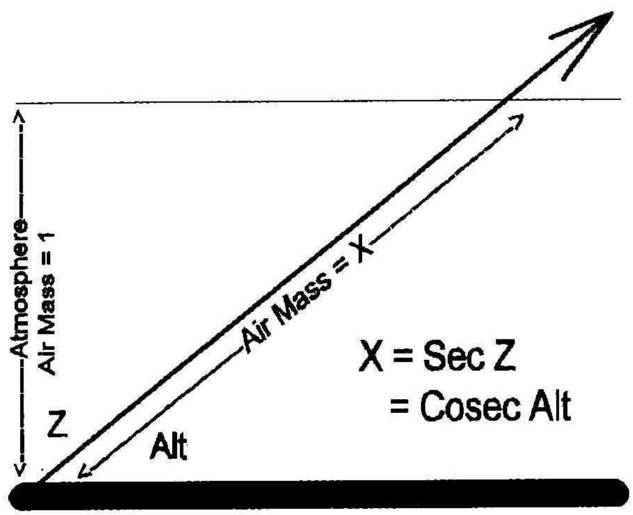


Figure 8

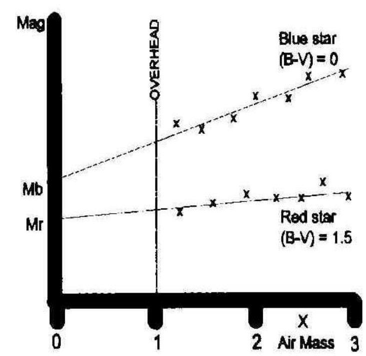


Figure 9

Conclusion

The principle object of this whole exercise is to provide our professional colleagues with high quality data, to an order of accuracy of 0.01 magnitude, and to be able to apply this to rapid changes say in the outburst of a cataclysmic variable. This will enable them to do a more thorough analysis of what is going on. A successful outcome will depend on many factors - the equipment available and skill in handling it, the care in processing and photometry on the computer, and the reduction of the data thus obtained.

I hope to be able to go into more practical details in future issues.

Recent observations of W UMa

JOHN SAXTON

Introduction

This note describes my observations of the contact binary W UMa, made with my 216 mm reflector and photoelectric photometer at Lymm, Cheshire. The photometer uses a Hamamatsu 1P28 PMT operated at -950 V; the output current goes to an op-amp current-to-voltage converter and then to a voltage-to-frequency converter, using electronics very similar to those described by Hollis (1995). Observations were obtained on 1997 March 20-21, March 21-22, April 15-16 and 1998 May 3-4. HD 85364 was used as the comparison star. A few measurements were made of a check star, HD 81790. Observations have been transformed to the standard system assuming HD 85364 to have V=6.50, B-V= 1.13, and W UMa to have B-V=0.80. W UMa has an orbital period just 26 seconds longer than 8 hours, so that the lightcurve repeats at the same phase about 1 minute later on successive nights. This may prevent coverage of the complete lightcurve if observations can only be made over a restricted portion of the night, and over a limited time interval. Total phase of primary eclipse lasts about 24 minutes; obtaining satisfactory coverage of total phase is thus something of a challenge with a manually operated single channel photoelectric system.

Eclipse Timings

I have derived three new times of minima from my data, using the method of Kwee and van Woerden. The minima times are listed below:

Date	Min	HJD
1997 March 21	II	2450527.5533 +/- .0002
1997 April 15	I	2450554.4099 +/-.0003
1998 May 3	I	2450937.4215 +/- .0003

Shortly after obtaining my 1997 observations, IBVS 4517 appeared, which describes observations of W UMa made in April 1997 by N Morgan, M Sauer and E Guinan at Villanova Observatory, as well as a list of eclipse timings going back to 1982. This prompted me to track down other eclipse timings of W UMa, which I did with the aid of the SIMBAD database. I was then able to plot figure 1, showing O-C from 1981 to the present. O-C is relative to 2441004.3977 + 0.33363696 E, which was obtained from Sky Catalogue 2000.0 (eds. A Hirschfield and R W Sinnott).

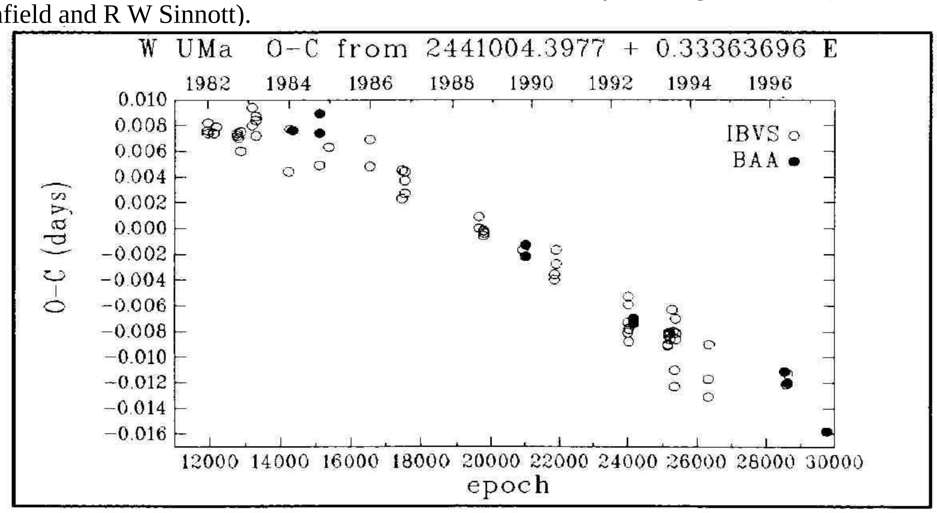


Figure 1

Most of the timings in this figure are from the IBVS, although BAA timings from past issues of the VSSC were used and are indicated on the figure. The BAA timings are, in order: one by A J Hollis, a pair by J Ells, a pair by J Watson, another pair from the Jack Ells APT and finally my 1997 and 1998 timings. You can see the good agreement with the BAA timings with those of other observers. The period appeared to shorten around 1985, and has remained more or less constant since then (indicated by the points forming a roughly linear trend). I therefore derived a new ephemeris by fitting a straight line to the data from epoch 15500 onwards. My new ephemeris is **min I = 2441004.4277 + 0.33363544 E**. This ephemeris yields an average O-C of zero for E>15500, as shown in figure 2.

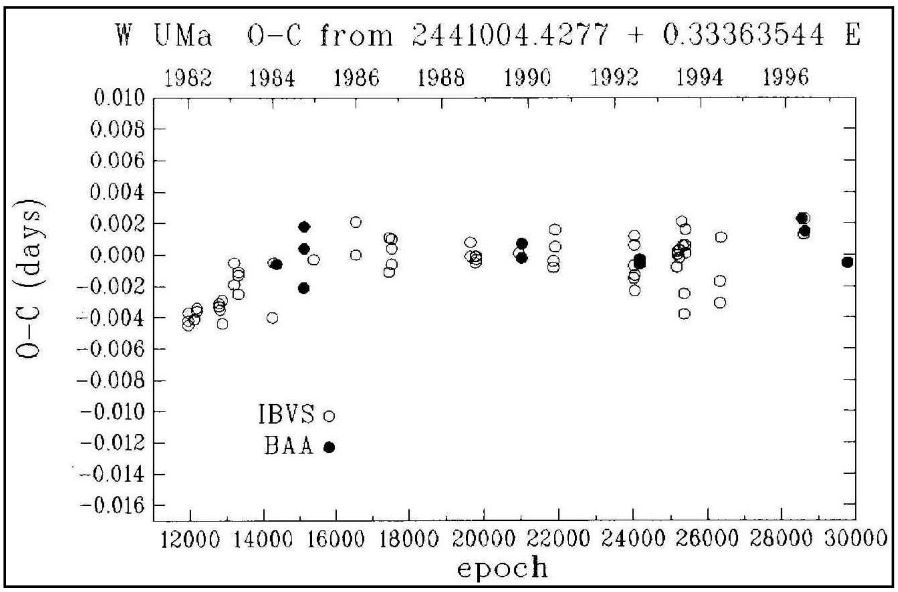


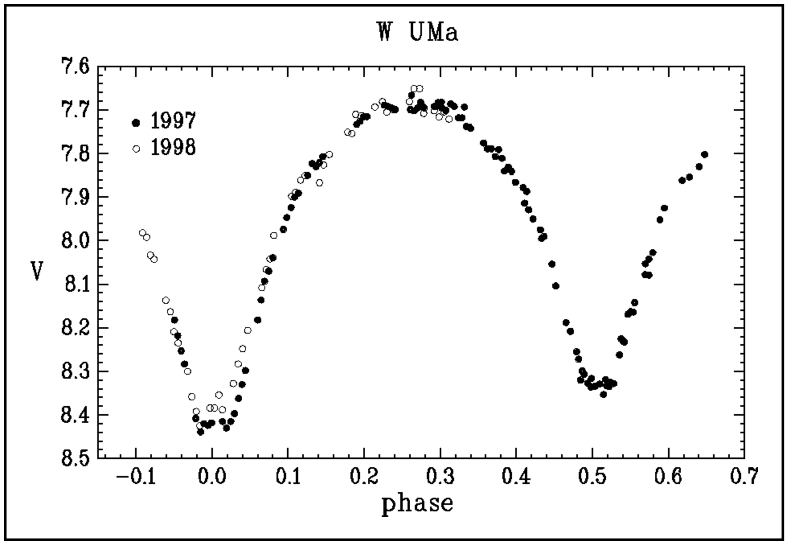
Figure 2

However, the scatter in O-C is much larger than the precision in a good eclipse timing. In particular, note that my eclipse timings are accurate to about 0.0003 days, but the O-C for the 1997 and 1998 data differ by about 0.002 days, which is outside of error. I return to this point below.

Light Curves

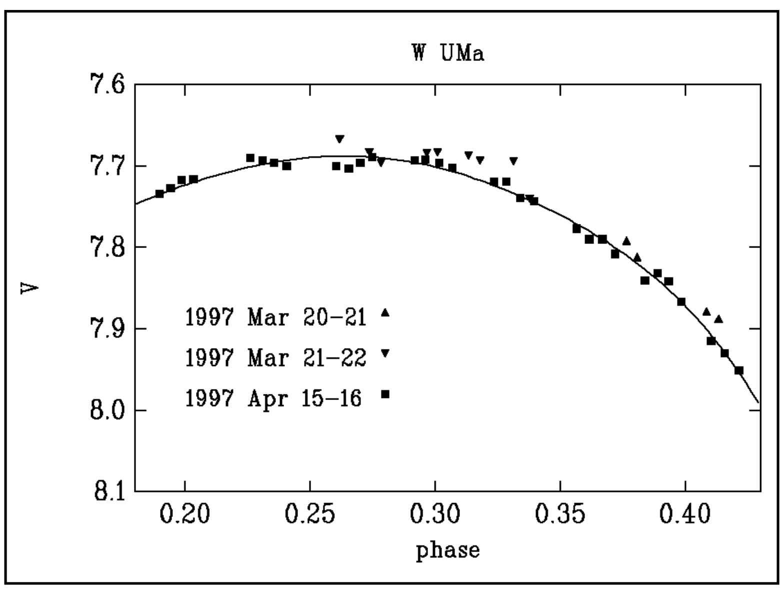
A characteristic of many contact binaries is that the light curve is variable with time. This is normally attributed to the presence of starspots. W UMa itself shows a variable lightcurve (e.g. Linnell 1991, and references therein), but it is not clear if any long term periodicity - perhaps related to a starspot cycle - is present. Consequently, lightcurves are of interest in addition to eclipse timings. My data are shown in figure 3. Notice that the 1997 April 15-16 data show a flat bottomed primary eclipse. Primary eclipse in a high inclination W-type contact binary corresponds to the occultation of the secondary (smaller, less massive) component which has slightly higher luminosity (per unit area) than the primary, and is indeed expected to be flat bottomed (provided the distribution of starspots is fairly homogeneous). My 1997 observations show primary minimum to be about 0.09 mags deeper

Figure 3



than secondary minimum. In IBVS 4517, Morgan et al report that their observations in April 1997 show that primary and secondary minimum differ by 0.03 mags; this is not in accord with figure 3, and is evidence of changes in the W UMa light curve. The 1998 data show some interesting differences to the 1997 data. First, primary eclipse is about 0.05 magnitude shallower in the May 1998 data than it was in the April 1997 data. (The magnitude difference between comparison and check stars was reproducible to about 0.01 magnitude). The 1998 data are also brighter immediately following primary minimum. Prior to primary minimum (on the descent

Figure 4



into eclipse) all data - both 1997 and 1998 - are in good agreement. It is now interesting to consider the scatter in O-C of eclipse timings. In principle, that primary eclipse on 1998 May 3-4 had O-C about 0.002 d earlier than the 1997 data could indicate either (1) the orbital period of W UMa has changed and/or (2) the time of mid-eclipse obtained from the light curve does not correspond to the instant of conjunction predicted by the ephemeris; such a situation might arise if the lightcurve is distorted by the presence of starspots. The changes in light curve shape indicate that changes have indeed taken place in the starspot distribution, and suggest that this is the cause of the scatter in O-C.

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Other sources of O-C data are: N Morgan et al, IBVS 4517; Z. Muyesseroglu et al, IBVS 4380; Z. Muyesseroglu et al, IBVS 4027; E Wunder et al, IBVS IBVS 3760; D Hanzl, IBVS 3423; V Keskin and E Pohl, IBVS 3355; A Dolzan IBVS 3177; B M Davan, IBVS 2745; A P Linnell, IBVS 2535; M Hamzaoglu et al, IBVS 2282; E Pohl et al, IBVS 2385.

IBVS's

GARY POYNER

4543 Accurate co-ordinates for variable stars. (Williams, 1998)
4544 Determining the period of an eclipsing binary: V1094 Tau = DHK41. (Kaiser & Frey, 1998)
4545 New variable stars in the open cluster NGC 7654 (=M52). (Choi et al, 1998)
4546 NSV 03199: An eclipsing binary system in Auriga. (Garcia-Melendo & Henden, 1998)
4547 A model for V4 in the globular cluster M3. (Corwin & Carney, 1998)
4548 The discovery of two new double mode RR Lyrae (RRd) variables in the globular cluster M3. (Corwin et al, 1998)
4549 The nature of V829 Aql - A triple mode radially pulsating post main sequence
delta Scuti star. (Handler et al, 1998)
4550 HD 17892, a new delta Scuti star. (Handler, 1998)
4551 Stromgren photometry of the T Tauri star SU Aurigae: Eclipse-like variability and age determination. (Dewarf et al, 1998)
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4553 On the recent Nova in NGC 205. (Sharov& Alksnis, 1998)
4554 BI CVn: A study of its period and a new photoelectric light curve. (Vandenbroere, 1998)
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4556 A new double mode Cepheid in Cassiopeia. (Antipin, 1998)
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4558 Eclipse observations of AM Tau. (Sippel et al, 1998)
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4570 Photometry and spectroscopy of V841 Cen in 1984/5. (Innis et al, 1998)
4571 Pulsating AGB star in the symbiotic Nova PU Vulpeculae. (Chochol et al, 1998)
4572 Ba II line as Cepheid luminosity indicator. I. (Andrievsky, 1998)
4573 Spectroscopic and photometric variations of HR 5. (Wber & Strassmeier, 1998)
4574 Photometric investigation of the nebula in the AG Peg system. (Tomov & Tomova, 1998)
4575 New or undesignated variables. (Gombert, 1998)
4576 A newly discovered BY Dra type star: HD 134319. (Messina & Guinan, 1998)
4577 A note on the period behaviour of BL Eridani. (Molik, 1998)
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4579 TiO and V-band photometry of the pulsating red giant V CVn. (Wasatonic & Guinan, 1998)
4580 PZ Mon - an active evolved star. (Saar, 1998)
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4582 Report on new observations of NSV 06391. (Garcia-Melendo, 1998)
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4588 Recent outburst of AG Dra has finished. (Petrik et al, 1998)
4589 To owners and keepers of plate collections obtained, to study flare stars in star clusters. (Gershberg, 1998)
4590 Precise lightcurve elements for HD 143213. (Bastian & Born, 1998)
4591 On the variability of S stars as observed by the Hipparcos satellite. (Adelman & Maher, 1998)
4592 A new delta Scuti variable star - SAO 16394. (Zong-Li et al, 1998)
4593 Discovery of pulsations in the double star HD 13079. (Martinez et al 1998)
4594 Observation of the optical counterpart of GRB 970508. (Nalezyty, 1998)
4595 Periodic light variation in B416, a luminous blue star in M33. (Shemmer & Leibowitz, 1998)
4596 HD 62454 - a new spectroscopic binary. (Kaye, 1998)
4597 Times of minima of eclipsing binaries. (Sandberg Lacy et al, 1998) (includes KP Aql, WW Cam, AY Cam, IT Cas, PV Cas, V459 Cas, EK Cep, RT CrB, V442 Cyg, V541 Cyg, V909 Cyg, V364 Lac & RU Mon)
4598 Does V694 Mon enter an inactive phase? (Mikolajewski et al, 1998)
4599 New radial velocities and orbital solution of the active binary star AR Lacertae. (Marino et al, 1998)
4600 Flare star search in the Alpha Persei cluster. II. (Semkov et al, 1998)

LETTERS

Comparison Stars - re Tony Markham's response in VSSC 96

The subject of comparison stars is always an emotive topic for the visual observer. The main problem lies in the majority of variables being red - indeed it can easily be considered that all red stars are to some degree variable, even if we haven't yet discovered this. The essence of a satisfactory sequence is that the comparisons should not be variable and should be as closely matched to the variable in B-V index as possible. This latter is very important, as if not well matched the variation in brightness due to differential extinction as the pair rise and set can be significant. Binocular variables (and LPVs at maximum) can give major problems as they are predominently red and comparisons tend to be fairly distant - hence differential; extinction (especially if poorly colour matched) can be a significant source of error. Whilst I would not propose that sequences that satisfy most observers should be tinkered with, in many cases improvements can be helpful. Observers have different visual spectral responses and we must accommodate these. I would recommend that each sequence be checked against the Hipparchos data to verify the B-V indices for the variable and sequence - it may be revealing or at least highlight potential problem areas! Of course many variables change colour index with phase, so compromises are necessary. I remember Doug Saw commenting that W Cyg had so much scatter in the observations that most years a straight line drawn through the mean was as good a representation of its variation as any; I suspect this is due to the redness of the variable and the non-redness of the sequence stars. I did some UBV photometry of Nova Vul in 1986 and was surprised by the changes in colour index during the first month. I learnt more of the astrophysics from that, than from reading, and also the impossibility of selecting close matching comparisons. This prompted my letter to the Journal a couple of years back about the unfiltered observations of supernovae using CCDs (which unlocked a hornets nest of complaint from the unwary). I'd be interested in any of your comments.

Dr Andrew J Hollis **Tel UK 01606 883331**

ECLIPSING BINARY PREDICTIONS (Oct-Dec 1998)

TRISTRAM BRELSTAFF

The following predictions are calculated for an observer at 53 degrees north, 1.5 degrees west but should be usable for observers throughout the British Isles. The times of mid-eclipse appear in parentheses with the start and end times of visibility on either side. The times are hours GMAT, that is UT-12h. 'D' and 'L' are used to indicate where daylight and low altitude, respectively, prevent part of the eclipse from being visible. Charts for all of the stars included in these predictions (17 in all - see VSSC 96 for a list) are available from the Assistant Director at 10p each (please enclose a large SAE).

1998 Oct 1 Thu
U Cep D07(10)15
U Sge 11(17)13L
ST Per 14(18)17D
RW Tau 16(20)17D
TW Dra 16(21)17D

1998 Oct 2 Fri
RW Gem 11(16)17D

1998 Oct 3 Sat
Z Per D06(04)09
Z Vul 07(12)14L
Z Dra 10(13)15
SS Cet 11(16)17D

1998 Oct 4 Sun
TX UMa D06(02)07
RZ Cas D06(08)11
ST Per D06(10)14
SW Cyg 10(16)17D
RW Tau 10(15)17D
TW Dra 11(16)17D
Y Psc 15(19)16L

1998 Oct 5 Mon
U Sge D06(02)08
RW Gem L10(13)17D
RZ Cas 11(13)15

1998 Oct 6 Tue
Z Per D06(05)10
Z Dra D06(06)08
U Cep D06(10)15
SS Cet 10(15)17D
RZ Cas 15(18)17D

1998 Oct 7 Wed
TX UMa D06(04)08L
S Equ D06(07)12
TW Dra 07(12)17
RW Tau L07(09)14
Z Dra 12(14)17

1998 Oct 8 Thu
Z Vul D06(10)13L
U Sge D06(11)13L
Y Psc 09(14)16L
RW Gem L10(10)15

U Cep 17(22)17D

1998 Oct 9 Fri

SW Cyg D06(06)12
Z Per D06(07)12
SS Cet 10(14)17D
ST Per 13(17)17D

1998 Oct 10 Sat

TX UMa D06(05)08L
TW Dra D06(07)12
Z Dra D06(08)10
RZ Cas D06(08)10
RW Tau L07(04)08
S Equ 12(17)13L

1998 Oct 11 Sun

U Cep D06(10)14
RW Gem L10(06)12
RZ Cas 10(12)15
Z Dra 14(16)17D

1998 Oct 12 Mon

Z Per D06(08)13
Y Psc D06(08)13
ST Per D06(08)12
SS Cet 09(14)17D
RZ Cas 15(17)17D
X Tri 17(19)17D

1998 Oct 13 Tue

TW Dra D06(03)08
TX UMa D06(07)08L
Z Vul D06(08)13
TX UMa L10(07)11
SW Cyg 13(19)17D
X Tri 16(19)17D
U Cep 17(21)17D

1998 Oct 14 Wed

S Equ D06(03)09
Z Dra 07(09)12
X Tri 15(18)17D

1998 Oct 15 Thu

U Sge D06(06)11
Z Per D06(10)14
SS Cet 08(13)17D
RW Tau 12(16)17D
X Tri 15(17)17D
Z Dra 15(18)17D
TW Dra 17(22)17D

1998 Oct 16 Fri

Y Psc D06(03)07
RZ Cas D06(07)10
TX UMa D06(08)08L
U Cep D06(09)14
TX UMa L10(08)13
X Tri 14(17)17D

1998 Oct 17 Sat

S Equ 09(14)12L
RZ Cas 09(12)14
ST Per 11(15)17D
X Tri 13(16)17D

1998 Oct 18 Sun

Z Vul D06(05)11
SW Cyg D06(09)15
Z Per 06(11)16
RW Tau L07(11)16
SS Cet L08(12)17
Z Dra 09(11)13
U Sge 09(15)12L
TW Dra 12(17)17D
X Tri 13(15)17D
RZ Cas 14(16)17D
U Cep 16(21)17D

1998 Oct 19 Mon

TX UMa D06(10)07L
TX UMa L10(10)15
X Tri 12(15)17
RW Gem 16(21)17D
Z Dra 17(20)17D

1998 Oct 20 Tue

ST Per D06(07)11
Z Vul 11(16)13L
X Tri 11(14)16

1998 Oct 21 Wed

S Equ D06(00)06
Z Dra D06(04)07
U Cep D06(09)14
RW Tau L06(05)10
Z Per 07(12)17
TW Dra 08(13)18D
SS Cet L08(12)17
X Tri 11(13)16

1998 Oct 22 Thu

RZ Cas D06(07)09
TX UMa 07(11)07L
TX UMa L10(11)16
X Tri 10(13)15
Z Dra 10(13)15
RW Gem 12(18)18D
SW Cyg 17(23)17L

1998 Oct 23 Fri

Z Vul D06(03)08
RZ Cas 09(11)14
X Tri 09(12)14
Y Psc 11(15)15L
U Cep 16(21)18D

1998 Oct 24 Sat

TW Dra D06(08)13
S Equ D06(11)12L
SS Cet L07(11)16
X Tri 09(11)14
Z Per 09(14)18D
RZ Cas 13(16)18D

1998 Oct 25 Sun

Z Dra D06(06)08
U Sge D06(09)12L
X Tri 08(10)13
Z Vul 09(14)12L
RW Gem 09(14)18D
TX UMa L10(13)18
ST Per 10(14)18D

1998 Oct 26 Mon

U Cep D06(09)13
X Tri 07(10)12
Z Dra 12(14)17
RW Tau 14(18)18D

1998 Oct 27 Tue

TW Dra D06(03)08
Y Psc D06(10)14
SW Cyg 06(13)17L
X Tri 07(09)12
SS Cet L07(11)15
Z Per 10(15)18D

1998 Oct 28 Wed

Z Vul D06(01)06
ST Per D06(06)10
RZ Cas D06(06)08
X Tri 06(08)11
RW Gem L08(11)16
TX UMa 10(14)18D
U Cep 16(20)18D

1998 Oct 29 Thu

Z Dra D06(08)10
X Tri D06(08)10
RW Tau 08(13)17
RZ Cas 08(11)13
TW Dra 18(23)18D

1998 Oct 30 Fri

X Tri D05(07)10
Z Vul 07(12)12L
SS Cet L07(10)15
Z Per 11(16)18D
RZ Cas 13(15)18
Z Dra 14(16)18D
ST Per 17(21)18D

1998 Oct 31 Sat

Y Psc D05(04)09
X Tri D05(06)09
S Equ D05(08)12L
U Cep D05(08)13
RW Gem L08(08)13
TX UMa 11(16)18D
RZ Cas 18(20)18D

1998 Nov 1 Sun

SW Cyg D05(02)08
U Sge D05(03)09
X Tri D05(06)08
RW Tau L06(07)12
V640 Ori L11(09)11
TW Dra 13(18)18D

1998 Nov 2 Mon

X Tri D05(05)07
SS Cet L07(09)14
Z Dra 07(09)12
ST Per 09(13)17
Z Per 13(18)18D
U Cep 15(20)18D

1998 Nov 3 Tue

X Tri D05(04)07
RZ Cas D05(05)08
RW Gem L08(05)10
V640 Ori L11(09)12
TX UMa 13(17)18D
Z Dra 16(18)18D

1998 Nov 4 Wed

X Tri D05(04)06
Z Vul D05(10)12L
RW Tau L06(02)06
U Sge 07(12)11L
RZ Cas 08(10)12
TW Dra 08(13)18D

1998 Nov 5 Thu

X Tri D05(03)05
ST Per D05(04)08
U Cep D05(08)13
SS Cet L07(09)13
SW Cyg 10(16)16L
V640 Ori L11(10)12
RZ Cas 12(15)17
Z Per 14(19)18D

1998 Nov 6 Fri

Z Dra 09(11)14
TX UMa 14(19)18D
RW Tau 15(20)18D
RZ Cas 17(19)18D

1998 Nov 7 Sat

S Equ D05(05)10
TW Dra D05(09)14
V640 Ori L11(10)13
Y Psc 12(17)14L

U Cep 15(20)18D
ST Per 16(20)18D
Z Dra 17(20)18D

1998 Nov 8 Sun

SS Cet L06(08)13
Z Per 16(20)18D
RW Gem 17(22)18D

1998 Nov 9 Mon

Z Dra D05(04)07
RZ Cas D05(05)07
Z Vul D05(08)11L
RW Tau 10(15)18D
V640 Ori L11(11)13
TX UMa 16(20)18D

1998 Nov 10 Tue

TW Dra D05(04)09
SW Cyg D05(06)12
U Cep D05(08)12
RZ Cas 07(10)12
ST Per 07(12)16
S Equ 10(15)11L
Z Dra 10(13)15

1998 Nov 11 Wed

U Sge D05(07)10L
SS Cet L06(07)12
Y Psc 07(11)14L
V640 Ori L10(11)14
RZ Cas 12(14)17
RW Gem 14(19)18D
Z Per 17(22)18D

1998 Nov 12 Thu

RW Tau D05(09)14
U Cep 15(19)18D
RZ Cas 16(19)18D
TX UMa 17(22)18D

1998 Nov 13 Fri

ST Per D05(03)07
Z Dra D05(06)08
V640 Ori L10(12)14

1998 Nov 14 Sat

S Equ D05(02)07
Z Vul D05(05)11
SS Cet L06(07)11
U Sge 10(16)10L
RW Gem 11(16)18D
Z Dra 12(15)17
SW Cyg 13(20)15L
SW Cyg L17(20)18D
X Tri 18(20)18L

1998 Nov 15 Sun

RW Tau D05(03)08
RZ Cas D05(04)07
Y Psc D05(06)10
U Cep D05(07)12
V640 Ori L10(12)15
TW Dra 14(19)18D
ST Per 15(19)18D
X Tri 17(19)18L

1998 Nov 16 Mon

RZ Cas 07(09)11
X Tri 16(19)18L

1998 Nov 17 Tue

Z Dra 05(08)10
SS Cet L06(06)11
S Equ 07(12)10L
RW Gem 07(13)18
V640 Ori L10(13)15
RZ Cas 11(14)16
U Cep 14(19)18D
X Tri 16(18)18L
RW Tau 17(22)18D

1998 Nov 18 Wed

Z Per D05(00)05
U Sge D05(01)07
ST Per 06(10)14
TW Dra 09(14)18D
Z Dra 14(16)18D
X Tri 15(17)17L
RZ Cas 16(18)18D

1998 Nov 19 Thu

TX UMa D05(01)05L
Z Vul D05(03)09
SW Cyg D05(09)15L
V640 Ori 10(13)16
X Tri 14(17)17L

1998 Nov 20 Fri

U Cep D05(07)12
SS Cet L06(06)10
RW Gem L07(09)14
RW Tau 12(16)18D
X Tri 14(16)17L

1998 Nov 21 Sat

Z Per D05(02)07
ST Per D05(02)06
RZ Cas D05(04)06
TW Dra D05(10)15
U Sge D05(10)10L
Z Dra 07(09)12
Z Vul 09(14)10L
V640 Ori 11(14)16
X Tri 13(15)17L

1998 Nov 22 Sun

TX UMa D05(03)05L
RZ Cas 06(08)11
X Tri 12(15)17
U Cep 14(19)18D
Z Dra 16(18)18D

1998 Nov 23 Mon

SS Cet L05(05)10
RW Tau 06(11)15
RW Gem L07(06)11
RZ Cas 11(13)15
V640 Ori 11(14)17
X Tri 11(14)16
ST Per 13(17)18D
SW Cyg 17(23)18D

1998 Nov 24 Tue

SW Cyg D05(<<)05
Z Vul D05(01)06
Z Dra D05(03)05
Z Per D05(03)08
TW Dra D05(05)10
S Equ D05(09)10L
X Tri 11(13)16
RZ Cas 15(18)18D

1998 Nov 25 Wed

TX UMa D05(04)05L
U Cep D05(07)11
TX UMa L08(04)09
Z Dra 09(11)14
X Tri 10(13)15
V640 Ori 12(14)17

1998 Nov 26 Thu

RW Tau D05(05)10
ST Per D05(09)13
SS Cet L05(04)09
RW Gem L07(03)08
Z Vul 07(12)10L
Y Psc 08(13)13L
X Tri 09(12)14
Z Dra 17(20)18D

1998 Nov 27 Fri

TW Dra D05(00)05
RZ Cas D05(03)05
Z Per D05(04)09
X Tri 09(11)14
V640 Ori 12(15)17L
U Cep 14(18)19D

1998 Nov 28 Sat

Z Dra D05(04)07
U Sge D05(04)09L
RZ Cas 05(08)10
SW Cyg 07(13)15L
TX UMa L07(06)10
X Tri 08(11)13
SW Cyg L16(13)19D
RW Gem 18(24)19D

1998 Nov 29 Sun

SS Cet L05(04)08
X Tri 07(10)12
RZ Cas 10(12)15
Z Dra 11(13)15
V640 Ori 13(16)17L
TW Dra 15(20)19D

1998 Nov 30 Mon

Z Per D05(06)11
U Cep D05(06)11
Y Psc D05(07)12
X Tri 07(09)12
RZ Cas 15(17)19D

1998 Dec 1 Tue

S Equ D05(06)09L
Z Vul D05(10)10L
X Tri 06(08)11
TX UMa L07(07)12
U Sge 08(14)09L
ST Per 12(16)19D
V640 Ori 13(16)17L
RW Tau 13(18)19D
RW Gem 15(20)19D

1998 Dec 2 Wed

Z Dra D05(06)08
SS Cet L05(03)08
X Tri 05(08)10
TW Dra 10(15)19D
U Cep 13(18)19D

1998 Dec 3 Thu

RZ Cas D05(03)05
SW Cyg D05(03)09
X Tri D05(07)10
Z Per D05(07)12
Z Dra 12(15)17
V640 Ori 14(16)17L

1998 Dec 4 Fri

Y Psc D05(02)06
X Tri D05(06)09
RZ Cas D05(07)10
ST Per D05(08)12
TX UMa L07(09)13
RW Tau 08(13)17
RW Gem 12(17)19D

1998 Dec 5 Sat

SS Cet D05(02)07
X Tri D05(06)08
U Cep D05(06)11
TW Dra 05(10)16
RZ Cas 10(12)14
V640 Ori 14(17)17L

1998 Dec 6 Sun
X Tri D05(05)08
Z Vul D05(08)09L
Z Per D05(08)13
Z Dra 05(08)10
RZ Cas 14(17)19D
1998 Dec 7 Mon
X Tri D05(04)07
RW Tau D05(07)12
TX UMa L07(10)15
RW Gem 09(14)19D
SW Cyg 10(16)14L
U Cep 13(18)19D
Z Dra 14(16)19D
V640 Ori 15(17)17L
SW Cyg L16(16)19D
1998 Dec 8 Tue
SS Cet D05(02)06
S Equ D05(03)08
X Tri D05(04)06
TW Dra D05(06)11
U Sge D05(08)09L
1998 Dec 9 Wed
X Tri D05(03)06
Z Per 05(10)15
ST Per 11(15)19L
V640 Ori 15(18)17L
1998 Dec 10 Thu
RW Tau D05(01)06
X Tri D05(02)05
U Cep D05(06)10
RZ Cas D05(07)09
RW Gem L06(11)16
TX UMa 07(12)16
Z Dra 07(10)12
1998 Dec 11 Fri
SS Cet D05(01)06
TW Dra D05(01)06
Z Vul D05(06)09L
S Equ 08(13)09L
RZ Cas 09(11)14
Y Psc 10(14)12L
Z Dra 16(18)19D
V640 Ori 16(18)16L
1998 Dec 12 Sat
SW Cyg D05(06)12
ST Per D05(06)10
Z Per 06(11)16
U Cep 13(17)19D
RZ Cas 14(16)18
RW Tau 15(20)18L
1998 Dec 13 Sun
Z Dra D05(03)05
RW Gem L05(07)13
TX UMa 08(13)18
TW Dra 16(21)19D
RZ Cas 18(21)19D
Z Vul L19(16)19D
1998 Dec 14 Mon
SS Cet D05(01)05
Z Dra 09(11)14
ST Per 18(22)18L
1998 Dec 15 Tue
S Equ D05(00)05
U Sge D05(02)08
U Cep D05(05)10
Y Psc D05(09)11L
Z Per 08(13)17
RW Tau 10(14)18L
Z Dra 17(20)19D
1998 Dec 16 Wed
Z Vul D05(03)09
RZ Cas D05(06)08
RW Gem L05(04)09
TX UMa 10(15)19D
TW Dra 11(16)19D
SW Cyg L15(20)19D
1998 Dec 17 Thu
Z Dra D05(04)07
RZ Cas 08(11)13
ST Per 09(13)17
U Cep 12(17)19D
1998 Dec 18 Fri
RW Tau D05(09)14
S Equ 05(10)08L
U Sge 06(11)08L
Z Per 09(14)18L
Z Dra 11(13)15
RZ Cas 13(15)18
Z Vul L18(14)19D
1998 Dec 19 Sat
Y Psc D05(03)08
RW Gem L05(01)06
TW Dra 06(11)16
TX UMa 12(16)19D
RZ Cas 18(20)19D
1998 Dec 20 Sun
ST Per D05(05)09
U Cep D05(05)10
1998 Dec 21 Mon
Z Vul D05(01)07
RW Tau D05(03)08
Z Dra D05(06)09
SW Cyg D05(10)13L
Z Per 10(15)18L
SW Cyg L15(10)16
RW Gem 17(22)19L
U Sge L19(20)19D
1998 Dec 22 Tue
RZ Cas D05(06)08
TW Dra D05(07)12
U Cep 12(17)19D
Z Dra 12(15)17
TX UMa 13(18)19D
X Tri 15(17)15L
ST Per 16(20)18L
1998 Dec 23 Wed
Z Vul 07(12)08L
RZ Cas 08(10)13
X Tri 14(17)15L
RW Tau 17(22)17L
1998 Dec 24 Thu
Z Per 12(17)18L
RZ Cas 12(15)17
RW Gem 13(19)19L
X Tri 14(16)15L
1998 Dec 25 Fri
TW Dra D05(02)07
U Cep D05(05)09
U Sge D05(05)08L
S Equ D05(07)08L
Z Dra 06(08)10
ST Per 08(12)16
X Tri 13(15)15L
TX UMa 15(19)19D
RZ Cas 17(20)19D
SW Cyg 17(23)19D
Z Vul 18(23)19D
1998 Dec 26 Sat
SW Cyg D05(<<)05
RW Tau 11(16)17L
X Tri 12(15)15L
Z Dra 14(17)19D
1998 Dec 27 Sun
RW Gem 10(15)18L
X Tri 12(14)15L
U Cep 12(16)19D
Z Per 13(18)18L
TW Dra 16(21)19D
1998 Dec 28 Mon
ST Per D05(04)08
RZ Cas D05(05)07
Z Vul D05(10)08L
X Tri 11(13)15L
TX UMa 16(21)19D
U Sge L18(15)19D
1998 Dec 29 Tue
RW Tau 06(11)15
RZ Cas 07(10)12
Z Dra 07(10)12
X Tri 10(13)15L
1998 Dec 30 Wed
U Cep D05(04)09
Y Psc 06(10)10L
RW Gem 07(12)17
SW Cyg 07(13)12L
X Tri 09(12)14
TW Dra 12(17)19D
RZ Cas 12(14)17
SW Cyg L14(13)19D
Z Per 14(19)18L
ST Per 15(19)17L
Z Dra 16(18)19D
Z Vul L17(21)19D
1998 Dec 31 Thu
X Tri 09(11)14
RZ Cas 17(19)19D
TX UMa 18(22)19D
U Sge 18(24)19D

The deadline for contributions to the December issue of VSSC will be7th November. All articles should be sent to the editor (details are given on the back of this issue)

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