British Astronomical Association

VARIABLE STAR SECTION CIRCULAR

No 121, September 2004

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Office: Burlington House, Piccadilly, London, W1V 9AG
Eclipse of Algol, Observations by Tony Markham

The deadline for contributions to the issue of VSSC 122 will be 7th November, 2004. All articles should be sent to the editor (details are given on the back of this issue)

Whilst every effort is made to ensure that information in this circular is correct, the Editor and Officers of the BAA cannot be held responsible for errors that may occur.
FROM THE DIRECTOR
ROGER PICKARD

I thought there was going to be little to report in this Circular, it being the summer months with their long light evenings, but things have not been that quiet.

Firstly, there was the eruption of a new variable in Hercules. Yuji Nakamura, Japan, reported the detection of a variable object of photographic magnitude 11.5 in Hercules on June 13.63UT using a 200mm f4 lens. Thoughts at the time of writing, are that it may be a WZ Sge type star. The fact that such a relatively bright star should be unknown, shows how important it is to keep monitoring the skies.

Which brings me to the second discovery. This was by a relative newcomer to astronomy, and a BAA member of only two months standing, Richard Best, who noticed that a star in M27 in an image he had taken last year was absent in an image from this year. He sent a query to Stewart Moore (BAA Deep Sky Director), who relayed it to Guy Hurst and myself. Guy quickly traced it to NSV 24959, and later Owen Brazell added that the object was discovered by Leos Ondra in 1988 (there is a nice report at: http://leo.astronomy.cz/gl/gl.html). It’s probably a Mira and it’s certainly below V magnitude 16 at the moment, but in November 1994 it was at approx magnitude 12, so we need to keep monitoring it to determine its range and period.

So, all in all, don’t give up on continuously monitoring the sky. You never know what will be discovered next.

Five Years as Director

By the time you read this I will have completed five years as Director of the BAA VSS, having taking over from Gary Poyner on 1st September 1999. During that time there have been a number of problems to overcome, not least of which was Dave McAdam’s retirement. This necessitated splitting the work he had done for the Section into two parts consisting of the database and the web pages, and I’m grateful to John Saxton for handling the former and initially Peter Moreton, and now Dave Grover the latter.

Other notable events during the last 5 years, have included the production of an index to Circulars 71-100; the first two-day Section Meeting; the mentoring scheme; the CCD target list; the production of the Circulars in pdf format and the introduction of an electronic alert service.

It is also interesting to note that the number of observations reported to the Section in 1998 (and summarised in the first Circular for which I was responsible) was approximately 31,000, which is almost the same figure as for 2003. It’s good to see our visual observers are maintaining their enthusiasm.

If there is one disappointment, it is that our database is still not available on-line, but hopefully, through the efforts of Roger Dymock and his Project Quixote, this will not be too long in forthcoming now.

I wish to thank all the Officers for their support and for the tremendous amount of work they undertake to keep the Section running smoothly.
Albert Jones DSc

I’m sure most members will be aware that Albert Jones is probably the greatest living variable star observer of our time, but for those that don’t know, here is a very short biographical note.

Albert is now 84 years old, and still observes on every possible occasion which includes many early morning sessions using a telescope he built in 1948. Indeed, only last year he re-discovered a variable star in the field of nova V5114 Sgr (this turned out to be V1592 Sgr - there is a typo in the GSC which gives the declination 10 arcmins north of its true position, so Albert just happened to see V1592 around maximum). He’s never totalled how many observations he’s made but apparently it is over 500,000! He modestly says that if he has made more estimates than someone else, it is because he has been at it for ages. Indeed, in January of this year he celebrated the 61st anniversary of his first attempt at estimating the brightness of a star (Nova Puppis 1942). He also says that he thinks his time is best spent observing and forwarding the estimates to the VSS of the RASNZ, and latterly to the AAVSO, and to those with the knowledge of maths and astrophysics to do justice to the analysis of the data. He doesn’t even make light curves of his own observations. “In that way I can go to the telescope with an open mind, trying to forget what it was last time, and not expecting the star to be brighter or fainter” he says. His observations are also very accurate and he has a regular request list for his observations from professional astronomers around the world. Even an observational programme using the Hubble Space Telescope was initiated following one of his recommendations.

Albert joined the BAA in 1945 and was Assistant Director of the Comet Section from 1952 to 1990. For his considerable work in establishing accurate magnitudes of comets he was awarded the Merlin Medal in 1968. Albert has also discovered two comets, the first in 1946 when he was 26, and the second in 2000 when he was 80, making him then the oldest person to find a comet at that time (Bill Bradfield may have been older when he found his latest comet). The 54-year gap between the two discoveries is also a record.

Apart from his joint discovery of SN 1987A, he was also awarded the OBE in the Queen’s Birthday honours list. An asteroid was named after him in 1988 in recognition of his achievements, and then last May he received an honorary doctorate of science from Victoria University of Wellington, NZ. Ever the one to shun the limelight he said “The ceremony was very emotional for me, being the centre of attention”.

Albert married Carolyn in 1984, his greatest discovery he says, and adds that the 20 years since then have been the happiest of his life.

The above information was gleaned partly from personal correspondence and from “Albert Jones - The Quiet Achiever” by Rodney R.D. Austin, Southern Stars, the Journal of the Royal Astronomical Society of New Zealand (INC.), 36, Numbers 1&2, December, 1994.

Peter Wheeler

I mentioned in the last Circular that Peter had now retired from the Section, but I should have added that besides observing, he also produced the index to Circulars 12-70.

Erratum

The editor apologises for the incorrect Alston Hall telephone number given on page 5 of VS120. The correct number is given on page 7 of this circular.
Albert Jones at the award ceremony.
The following new charts are now available from the Chart Secretary:

213.02 W CMa
Formally 213.01. A V sequence sourced from Tycho 2 has been introduced with stars B, D and F dropped, and replaced with stars G (SAO152438), H (SAO152402), K (SAO152442) and L (SAO152424). The new 9 degree field chart shows improved detail in this crowded region of the sky.

272.01 MisV1147 Cep
No previous BAA VSS chart existed for this recently discovered telescopic star (see VSS Circular 115, page 3). A 15 minute field chart has been drawn complete with a V sequence by Henden.

009.04 AH Her
Formally 009.03. New 1 degree and 20 minute field charts have been drawn. The previous mv sequence has been replaced and extended by a V sequence sourced from Tycho 2, TASS, West and Henden.

011.02 AY Lyr
Formally 011.01. New 1 degree and 15 minute field charts have been drawn. The previous mv sequence has been replaced and extended by a V sequence sourced from Henden.

024.02 RS Oph
Formally 024.01. New 9 degree and 1 degree field charts have been drawn. The previous mv sequence has been replaced by a V sequence sourced from Tycho 2, ASAS3 and Henden.

012.03 CN Ori
Formally 012.02. New 3 degree and 20 minute field charts have been drawn. The previous mv sequence has been replaced and extended by a V sequence sourced from Tycho 2 and Henden.

013.03 CZ Ori
Formally 013.02. New 3 degree and 15 minute field charts have been drawn. The previous mv sequence has been replaced and extended by a V sequence by Henden.

277.01 X Per
Formally MDT 1984 April 8. A new 9 degree field chart has been drawn. A V sequence has been introduced sourced from Tycho 2 and Pickard. Stars FL42, C and 12 have been dropped, and replaced with star D (SAO56951).

278.01 Z Psc
Formally JEI 10.11.69. A new 9 degree field chart has been drawn. A V sequence has been introduced sourced from Tycho 2 and Pickard. Stars D, E, C and G have been dropped and replaced with star N (SAO74721).

276.01 TX Psc
Formally MDT 72.05.27. A new 9 degree field chart has been drawn. A V sequence has been introduced sourced from Tycho 2. Stars F and H have been dropped, and replaced with star K (SAO128393).
**017.03 SU Tau**
Formally 017.02. New 1 degree and 10 minute field charts have been drawn. The previous mv sequence has been replaced and extended by a V sequence sourced from ASAS3 and Henden.

**271.01 TV UMa**
Formally MDT 1982 Aug 16. A new 9 degree field chart has been drawn. A V sequence has been introduced sourced from Tycho 2. Stars C (Groombridge 1830) and D (NSV19016) are both confirmed variables and have therefore been dropped. Stars G (SAO62635), H (SAO62590) and K (SAO62729) have been added.

**270.01 BK Vir**
Formally DAP 74.01.21. A new 9 degree field chart has been drawn. V magnitudes sourced from Tycho 2 have been applied to the existing sequence.

Thanks are due to Chris Jones who drew the charts for MisV1147 Cep and BK Vir.

**THE 2004 VARIABLE STAR SECTION MEETING**

Denis Buczynski and Roger Pickard

The British Astronomical Association Variable Star Section Residential weekend meeting for 2004 October 22-24, will be held at Alston Hall Residential College Longridge Preston, Lancashire PR3 3BP, from Friday early afternoon, until lunchtime Sunday.

To date the arranged speakers are as follows: Professor Don Kurtz (University of Central Lancashire), Mike Simonson (AAVSO), Bruce Sumner (AAVSO), Dr Keith Robinson (Lecturer in Astronomy), Denis Buczynski (CBO Lancaster), John Toone (BAA), Gary Poyner (BAA).

Other speakers have been invited and we await their replies. Time will be made available for any VSS members who would like to make a short contribution. There may be a session devoted to a debate, which members will be able to vote upon. The participants and the subject matter (contentious with some frivolity attached) are still under consideration. Any suggestions for this event would be welcomed!

All residential arrangements, which include accommodation, food/diet and any special needs have to be booked directly with ALSTON HALL. The basic cost for accommodation including all meals and refreshments is around 110 pounds, plus extra for supplements. Contact Dot Little at ALSTON HALL and discuss your requirements as soon as possible. The telephone number is 01772 784661; Fax number is 01772 785835; E-mail is alston.hall@ed.lancscc.gov.uk

As usual, residential space is limited to around 40 persons, so early reservation is essential. When you contact ALSTON HALL quote BAA Astronomy Weekend Oct 22-24. There will be spaces for any members who do not require accommodation but wish to attend on a daily basis. Anyone wanting to take this option should still book directly with ALSTON HALL to agree costs for any meals and refreshments. Anyone needing further details or anyone who would like to give a short talk should contact Denis Buczynski (evening telephone 01524 68530 or E-mail denis@cb978iau.demon.co.uk).

Residential/travel/direction/location details will be sent directly from ALSTON HALL to those who book. We look forward to seeing many of you at the meeting, and greeting you to beautiful Lancashire. It will be a great weekend, promise!
THE BAA VSS CCD PHOTOMETRY SPREADSHEET
DAVID BOYD, RICHARD MILES, ANDREW WILSON

Introduction

If you carry out time-sequence photometry of variable stars using a CCD camera, and subsequently use the AIP4WIN multi-image photometry routine to measure your images, then you might find this Excel spreadsheet useful for further analysing and reporting your observations. It also provides the most convenient route at present, for submitting your results to the new VSS CCD database. There will be an article about the CCD database in a future issue of the Circular.

The purpose of the spreadsheet is threefold. It lets you examine the content and quality of your data quickly, and so helps you to improve your observing technique; it provides a convenient way of recording all the relevant information about an observing run in one place for future reference, which is important if the data is to be of scientific use; and finally, it makes it very easy to submit your results to either the BAAVSS, the AAVSO or any other organisation as part of an observing programme.

The spreadsheet is intended for use with time-sequence differential photometry measurements of a single object (plus comparison and check stars), recorded with either no filter or a single photometric filter (e.g., U, B, V, R, or I). We are also developing further spreadsheets which will support observing runs on single objects using multiple filters, analysis of data for multiple objects, and absolute photometry.

The spreadsheet

After an extensive period of development and testing within the VSS CCD Working Group, the spreadsheet is now ready for exposure to a wider group of users. If you would like to try using it, you can obtain a copy by contacting the first-named author (DB) at drsboyd@compuserve.com.

Mostly the spreadsheet is self-explanatory if you spend a few minutes looking through it carefully. In particular, note the colour-coding of the various cells in the Results sheet. This tells you which cells you need to fill in with information about yourself and your equipment, your observing site, the objects being observed, and the observing session, and which cells the spreadsheet fills in automatically, either by importing data or by calculation. Some of the information, for example, about your observing site and equipment, will only need to be filled in the first time you use the spreadsheet and can then be copied for subsequent observing sessions. The information about the objects being measured will obviously need to be added each time. Don’t be tempted to dive in and edit the contents of individual cells without first considering whether this is appropriate! We will now give a few words of explanation about each sheet in the spreadsheet.

Results sheet

The main sheet of the spreadsheet is the one labelled Results. This stores all the relevant information about the observing session in the top section and then, lower down, it contains the results of analysing each image, one line per image. For each image it calculates the
differential magnitude of the V (variable) and K (check) stars relative to the C (comparison) star. There are lots of calculations embedded in this sheet so edit it with care! By studying these formulae you will be able to see how the results are being calculated. If you spot any mistakes, please let us know (see below).

**Buttons** sheet

The **Buttons** sheet enables you to run some useful macros, one which automatically imports the AIP4WIN multi-image photometry output data file into the lower section of the Results sheet, and three which generate report files in various formats. You can specify names for these files as appropriate. It is not necessary to use the import macro if you want to load your data into the Results sheet manually, for example if you are using software other than AIP4WIN, but do take care not to overwrite formulae in the Results sheet. The cells which the import macro fills are coloured black in the Results sheet.

**Data charts** sheet

The **Data charts** sheet is useful for seeing at a glance what your data looks like. There are plots of the measured V-C differential magnitude, both with and without error bars (more about errors later), and similar plots for K-C, so you can check that everything is behaving itself. There is a plot of the V, C and K instrumental magnitudes, which is a good way of checking on the quality of the observing conditions. The presence of any thin cloud or haze will immediately make its presence obvious on this plot and allow you to make value judgements on whether any of your data should be rejected. You will also see any deterioration in the data quality reflected in the size of the error bars in the V-C and K-C plots. These errors are mainly based on the number of photons from the objects which were recorded, and are therefore sensitive to effects like haze or dewing of your optics. Finally, there is a plot of the measured V-C differential magnitude, in which blocks of consecutive results are averaged. This can be useful if the data is a bit noisy and you want to smooth this out, but beware that it might also smooth out any real short term variation in the data.

**Image** sheet

The **Image** sheet provides somewhere for you to store an image of the field with the stars you used as V, C and K marked by AIP4WIN. A convenient way to do this on a PC is as follows. First delete the image currently in the Image sheet. Then click in the cell which was at the top left of the old image so that when you are ready to store the new image, it will go in the same place. The next stage of the process happens when you are using the AIP4WIN multi-image photometry routine to measure your images. While doing this you will have an image on the screen with circles and labels marking the V, C and K stars. Use the Print Screen button on the keyboard to take a copy of this screen onto the clipboard. Start up Microsoft Paint (or any other similar image manipulation program). In the case of Paint, this starts up with an empty image window. Use Paste to load the information currently on the clipboard into this window, then click on the dotted box at top left to select the cursor function. Use the cursor to select the part of the image you want to store in the spreadsheet. This should contain enough local context to make it clear which stars you are using. Use the Copy function to make a copy of this section of the image. Now go back to the Image sheet of the spreadsheet and select Paste. This should put a copy of the selected section of your image into the spreadsheet. This sounds complicated but becomes simple with practice. It is, of course, optional to do this, and it does make the spreadsheet file somewhat larger, but it could be very useful to
resolve any uncertainty in the future about which stars were actually measured. It’s not impossible to type an incorrect GSC number into the Results sheet! Figure 1, above, shows an example image.

Reporting sheets

There are three output file options for reporting your results, all activated using the Buttons sheet. These write out the contents of the Summary, AAVSO Report, Bulk Data and Individual Measurements sheets. You can inspect these sheets to see what they contain. The Bulk Data and Individual Measurements sheets are used to create another Excel spreadsheet file which you can submit to the VSS, and which will be used to load your data into the VSS CCD database. The AAVSO Report sheet is used to create a file which can be uploaded to the AAVSO WebObs on-line data entry system. It uses their generic data format. The Summary sheet contains sufficient information about your observations, including details of you and your equipment and the comparison and checks stars used, that you could send the Summary file to any other organisation to which you want to report your results. The time reported for each image in these output files is always the mid-exposure time. If necessary, this is calculated from the time given in the FITS header and the duration of the exposure.
Calculating errors

Finally errors. We mentioned above that the spreadsheet calculates errors on the individual magnitude measurements which it produces. These are largely based on the ADU counts which you have measured from each image but also take into account some parameters of your camera, namely gain, readout noise and dark current. You will need to fill these in on the Results sheet. The Berry and Burnell book Handbook of Astronomical Image Processing (1), which includes the AIP4WIN software, tells you how to measure these. Note that it refers to gain as conversion factor. You can sometimes find theoretical values for these on the specification leaflet for your camera. If you don’t know these, set the gain to 1 and the readout noise and dark current to 0 initially, but this will mean that your errors are not accurate. If you look in the cells which contain the errors you will see a complicated formula. This is based on an error formula, sometimes called the CCD Equation, which is widely used in the astronomical community and is written up in Howell’s book Handbook of CCD Astronomy (2).

Error-calculation is a very big subject and we won’t attempt to go into it further here. Suffice it to say that one of us (DB) has compared these calculated errors with the scatter of measurements of the check star in each of a large number of observing runs (the check star is supposed to have a constant magnitude so the scatter in these measurements gives an independent estimate of the actual measurement error) and finds that the error formula consistently slightly underestimates the actual error (3). This is to be expected since there will be other sources of error which the error formula does not take into account. For this observer, scaling the calculated errors up by 20% gives an excellent match to the actual observed errors. It is left as an exercise for the reader to see how these calculated errors compare with their own experience. What is in no doubt however, is that having an approximate estimate of the uncertainty on your measurements is much better than having no estimate.

Conclusion

So now you know about the new VSS CCD photometry spreadsheet. If you think it might be useful for you, get a copy and try using it. We will endeavour to answer any questions and deal with any bugs which you find still lurking in the spreadsheet. We would also be very interested to hear how you get on. In the first instance, contact the first-named author (DB) at drsboyd@compuserve.com.

References

3 Boyd D., ‘What photometric precision can I achieve?’, VSS Circular, No.199, March 2004
PHOTOELECTRIC MINIMA OF SOME ECLIPSING BINARIES

CAHIT YESILYAPRAK¹, TIMUR SAHIN¹

These binary stars were observed as a part of a project given to TUBITAK (The Scientific and Technical Research Council of Turkey) National Observatory (TUG). Some of the stars, such as V2150 Cyg and OU Ser, need much more data for both reliable O-C analysis, and defining the physical nature of these systems. The observations were performed in the Johnson V band, and reduction of the observations was made in the usual way (Hardie 1962). The standard error is included in each of the minimum times. The observations were reduced by using the method of Kwee and van Woerden (1956).

Introduction and Literature

Contact binaries are the most frequent type of eclipsing binaries. Nevertheless, many of them escape detection due to their small inclination angles, and their light variations can be well below the general detection limit of searches for variable stars. The photometric survey of the HIPPARCOS satellite has confirmed many such variables, and has produced a substantial number of new ones. In this study, we have surveyed the list of periodic variables in the Variability Annex of The HIPPARCOS Catalogue (ESA 1997) for known and new contact binaries. Stars which were classified as EW were examined (these are listed opposite in Table 1). Some of our results are given in Table 2.

From season to season significant variations are seen in the light curves of many short period eclipsing binary systems, especially the W Ursae Majoris type stars. These stars also experience period changes, which may or may not be associated with the light curve activity. We are also thinking of performing a detailed calculation for period changes, especially for both V2150 Cyg and OU Ser. These stars need complete light curves for detailed analysis in order not to smear out variations occurring on a time scale of days. The W UMa-type star AC Boo was first reported by Schieven et al (1983) to have experienced a period change at some time between 1973 and 1982. V2150 Cyg is another new binary system discovered by the Hipparcos Project. The Hipparcos light curve shows variations only slightly above 0.1 magnitude, indicating a low orbital inclination for V2150 Cyg. As noted by Lu et al (2001), this system is important since it can provide an extension of the absolute magnitude calibration toward early spectral types.

Observations and Results

For each star, the available times of minimum in the literature were used to predict times of minimum in order to determine the type of minimum. The minima times were computed with Kwee and van Woerden method (1956). The latter is given in column 4 (I = primary, II =secondary) for Table 2. Our present observations were taken with the TUG 0.40 m. reflecting telescope in conjunction with a (SSP5 type) PMT photoelectric photometer. Standard Johnson B and V filters were used. Reductions were made in usual way (Hardie 1962). Minimum times are corrected for light time effect.

¹Akdeniz University, Art & Science Faculty, Physics Department, Campus, 07058, Antalya /Turkey. E-Mails: cahity@akdeniz.edu.tr, timursahin@akdeniz.edu.tr
### Table 1: Variable and Comparison Stars

<table>
<thead>
<tr>
<th>Var Star</th>
<th>Coords RA. (J2000) DEC</th>
<th>Comp Star</th>
<th>B mag</th>
<th>V mag</th>
<th>Spec</th>
<th>Ep+Source (2400000+)</th>
<th>Period (d)</th>
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</thead>
<tbody>
<tr>
<td>AC Boo</td>
<td>14 56 28 46 21 44</td>
<td>GSC 3474 0052</td>
<td>9.10</td>
<td>10.08</td>
<td>F8Vn</td>
<td>51588.0118 (2)</td>
<td>0.352444</td>
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<tr>
<td>FI Boo</td>
<td>15 22 06 51 10 55</td>
<td>HD 136578</td>
<td>10.15</td>
<td>9.48</td>
<td>G5</td>
<td>48500.0390 (1)</td>
<td>0.194999</td>
</tr>
<tr>
<td>V2150 Cyg</td>
<td>21 18 11 30 35 22</td>
<td>SAO 71155</td>
<td>8.40</td>
<td>8.00</td>
<td>A0</td>
<td>48500.4340 (1)</td>
<td>0.591856</td>
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<tr>
<td>OU Ser</td>
<td>15 22 43 16 15 41</td>
<td>HD 136440</td>
<td>8.84</td>
<td>8.25</td>
<td>G5</td>
<td>48500.2780 (1)</td>
<td>0.296765</td>
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<tr>
<td>HN UMa</td>
<td>11 15 57 37 38 36</td>
<td>Hip 55651</td>
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<td>9.82</td>
<td>F8</td>
<td>48500.0781 (1)</td>
<td>0.382608</td>
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</table>

All stars in Table 1 are of EW type as listed in GCVS

Sources: (1) Hipparcos and Tycho Catalogues (ESA 1997), (2) Nelson, R.H. (2001), IBVS 5040

### Table 2: Times of Minima

<table>
<thead>
<tr>
<th>Star Name</th>
<th>Time of min. HJD (2400000+)</th>
<th>Error (d)</th>
<th>Type</th>
<th>Filter</th>
<th>O-C</th>
<th>Remarks</th>
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<td>II</td>
<td>V</td>
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<tr>
<td>FI Boo</td>
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<td>II</td>
<td>V</td>
<td>-0.0338</td>
<td>TS-HA</td>
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<td>V</td>
<td>-0.0273</td>
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<td>V</td>
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Observer codes: Cahit Yesilyaprapak (CY), Timur Sahin (TS), Halil Akteke (HA)

Acknowledgements:
The authors would like to thank the TUBITAK National Observatory (TUG) for the observing times and equipment support, and to Halil AKTEKE for contributions to observation of FI Boo.

References:
FLICKERING IN S5 0716+714

JOHN TOONE

One of the early major successes of the BAAVSS Alert Group is the prediction, visual detection and CCD confirmation of flickering in S5 0716+714.

S5 0716+714 was first noted to be exceptionally bright on the 17 January 2004 by Gary Poyner. Gary’s report read as follows:

*Have you seen S50716+71? Bright tonight at 12.3. Last observation was on Jan 14.897 at 13.4. I’ve been observing it since mid-1997, and this is the brightest I’ve seen it.*

Following confirmation of the outburst from other visual observers, Gary then put out the following alert on the 18 January 2004 requesting that observers monitor it closely for rapid variations:

*I think that during this active period, observations should be made hourly (or more frequently if possible). We’ve seen what happened in W Com and BL Lac a couple of years ago.*

On the 28 March 2004 I observed S5 0716+714 again in a bright state, but had difficulty making a confident estimate as it appeared to be unsteady in brightness. The following alert was posted on the morning of 29 March 2004:

*S5 0716+714 is continuing its active bright state.*

28 Mar 1042GMAT Equal 3 12.4 C8
Comparison used:
3 = GSC 4368 930 = 12.43

*Last night (28 Mar) S5 0716+714 appeared unsteady and I saw it alternately slightly brighter then fainter than comparison 3. The observation listed above is therefore a mean value.*

The following night (29 March 2004) David Boyd secured a 3 hour CCD run using a V band filter. Although the object had faded by around 0.5 magnitudes compared to the previous night, it was varying randomly over a range of 0.1 magnitude. David’s report on the 2 April 2004 reads:

*I recorded two 3 hr CCD photometry runs on this object using a V-band filter on 29 and 30 March. Unfortunately it wasn’t clear here at the time of the XTE TOO run on 28 March. It seems to be varying randomly by around +/-0.05 magnitudes. I’ve carried out a frequency analysis on the data but it didn’t produce any significant peaks which were consistent in both runs, so it looks like there’s no periodic component at a level I can detect.*

Light curves of David’s CCD runs on the 28 and 29 March 2004 were published in *The Astronomer*, Vol 41, No 481 (May 2004).

The above is clearly conclusive evidence of classical flickering behaviour. I estimate that on the 28 March the flickering must have been in the range of 0.3 magnitudes for it to have been detectable visually. To the best of my knowledge this is the first time significant flickering behaviour has been detected in S5 0716+714.
REPORT ON THE JOINT VS/I&I SECTION CCD PHOTOMETRY MEETING (PART 1)

MARK SHERBORNE (Sat am session) and STAN WATERMAN (Sat pm session)

The meeting was opened at 10:55am by Bob Marriott, who gave a brief introduction to the Variable Star Section and the Northampton Natural History Society. On display, and for attendees to examine later, was an extinction photometer used in the 19th century for variable star magnitude measurements.

Roger Pickard introduced the first speaker of the day, Professor Tim Naylor of the School of Physics at the University of Exeter, who talked about New CCD Projects for Amateur Telescopes.

Tim had worked for many years, at the University of Keele, which possessed a 24” telescope for the use of students and keen amateurs. This had been used, working in collaboration with amateurs to obtain lightcurves of the dwarf nova IP Peg and HT Cas, which are both eclipsing dwarf novae of great interest. Some of the most important work had been to discover whether the novae outbursts began at the inside of the accretion disc, expanding outwards with time, or the other way around. In practice, by monitoring the changing eclipse profiles, as the system progressed through its outburst, they were able to model the outburst's profile. As outbursts in these systems progress very rapidly, this is a field where amateurs can have a significant impact, by alerting other amateurs and professionals to the onset of outburst.

Tim explained that there were now 14 people in his Exeter University group working on a whole new set of problems associated with star and planet formation. The specific field of interest of the group is stars that are less than 10 million years old and are therefore pre-main sequence stars; low mass stars in this group (mass of < 1 solar mass) are known as T Tauri-type stars, whereas higher mass stars are known as Herbig Ae/Be type stars.

Exeter University students have access to a 10” Meade telescope, fitted with a ST7 CCD and guider system, and an SBIG spectrograph. The telescope is housed in a dome which is automatically controlled using Domeworks, which allows remote dome rotation, shutter operation, and also provides an interlock for the door. A PC which is located in the dome is remotely controlled from the control room. This equipment is funded by the Donald Barber Bequest. The seeing at the site was around 5 arcseconds which Tim described as being disappointing.

Tim then showed some H-R and Colour-Magnitude diagrams, that he had constructed using Hipparcos data, in which he emphasized the size of the spread of the pre-main sequence stars; the expectation is that the spread of stars shown on them would ‘tighten’ with time to drop onto the main sequence. However, there is still much that is not understood about pre-main sequence stars. As a star collapses during the formation process, and forms an accretion disc of the order of the size of the solar system, the inner part of the disc emits infrared radiation, and the magnetosphere of the star truncates the disk at 2-3 solar radii. It is thought that planets will later form in this disc.

Most star formation work done to date, concentrates on stars in the local area out to a distance of around 100pc, even though this is a star formation backwater. Most star formation
occurs in OB associations; the nearest of these is in Orion, at a distance of around 500pc, and most other known OB associations are further than 1000pc. Ultimately, if we are to understand how the Sun and Earth formed, we need to understand star formation in these OB associations.

Most pre-main sequence stars of interest at 1Kpc, would be of the order of 15.5$^{th}$ magnitude, which means that amateur telescopes capable of imaging such stars with a precision of 0.1 magnitude would be required for work on these systems. Tim stressed that whilst long-term monitoring of these systems might produce very valuable results, there was no guarantee that such work would be fruitful.

After several questions had been directed to Tim, Dr Peter Wheatley gave a talk entitled Robotic Telescopes: a threat to amateur observers?

Traditionally professional facilities have large telescopes in the 8-10m range, with narrow fields of view, inflexible scheduling and intense competition for time on them. A possible new future facility was the OWL (the Overwhelmingly Large Telescope) with an aperture of 100m! Amateur facilities are smaller but there are more of them, they have unlimited access, and they are good at long-term monitoring and alerting professionals of rare events. There were now, a new group of intermediate range telescopes including the Liverpool Telescope, which was a 2m aperture scope sited at La Palma which is fully robotic. The Liverpool Telescope has time allotted flexibly (down to seconds per night), and is queue-scheduled with hundreds of observations per night by potentially hundreds of observers. The telescope generates uniform, well-calibrated data with standard filters, and is capable of reaching a V magnitude of 21.5 in 20 seconds, and 23rd magnitude in 6 minutes; it also has a spectroscope and an infrared camera. Additionally, the Faulkes telescopes are a pair of similar 2m telescopes sited in Hawaii and Australia, that will be available for schools and amateurs to book time on.

Dr Wheatley went on to describe other medium size facilities currently in use or under construction, including REX (the Robotic Exoplanet discovery experiment), which consisted of 3x2m telescopes in the southern hemisphere; ROTSE-III, which consisted of small narrow field robotic telescopes of 45cm aperture, with 1.9 degree field of views, which are dedicated to gamma ray bursts; and the WASP (Wide Angle Sky Patrol) project, which would be able to follow up real-time alerts. The WASP telescope consisted of 8, 11cm aperture lenses, with 2048x2048 CCDs attached. These would be capable of reaching V=16.5 in 30 seconds with a field of view of 2% of the sky. The main current difficulty to overcome with this system was that of handling the massive amount of data that the system would generate each year - of the order of 30Tbytes!

Peter concluded that these searches represented both a threat and an opportunity for amateurs, in that many of the fields that had been traditionally covered by amateurs, might now be covered by other such instruments, but that there would, no doubt, be niches left available for amateurs, as well as the opportunity to trawl through the massive amounts of data from these systems that would be made publicly available.

Dr Richard Beare went on to present a talk on The Faulkes Telescope Project, funded by the Dill Faulkes Educational Trust. The aim of this project is to stimulate interest in science, maths and technology amongst young people. The two sites that have been selected for the two telescopes, in Australia and Hawaii, allow for daytime observations from the UK. These are the largest telescopes dedicated to education in the World, and are fully robotic, controlled through the internet, returning JPEG images for immediate inspection, with FITS format images
downloadable via the internet after the observing session. The two telescopes are identical to
the Liverpool Telescope, and are of 2m aperture with Richey-Chretien optics, 4 cassegrain
side ports and one cassegrain wide field. Tracking is better than 0.2 arcseconds, and they are
fitted with 2048 x 2048 CCD chips with a field of view of 4.6 x 4.6 minutes of arc. A Sloan
filter set is available, in addition to H-apha and OIII filters, and a basic spectrograph with a
resolution of 0.4nm. The dome is a clamshell, and the mount can slew from point to point in
less than a minute.

Suitable projects for these telescopes, include measuring the surface brightness profiles of
galaxies using DS9 software and spreadsheet packages, generating asteroid and comet light
curves to permit analysis of rotational periods (checked in the classroom using an illuminated
rotating potato known as a ‘rotato’!), star cluster age estimation using H-R data, and
classification and imaging of nebulae. The cost to amateurs, of using the telescopes is likely
to be around £250 per hour.

The first talk of the Saturday afternoon was given by Tonny Vannmunster, on CCD
Photometry of Transient Objects. Tonny explained that he wasn’t only going to talk about
transient objects and his subtitle was: A Universe of Pro-Am CCD projects waiting for your
coop-operation.

He started with a well known transient object, the Pro-Am study of the cataclysmic variable
WZ-Sge. This system has very rare, long-lived eruptions, and a large outburst amplitude
which makes it ideal for amateur observations. The amateurs have the time to watch and wait
for the outbursts, and then many of their time-series photometric observations of an eruption
can be combined to provide scientifically useful data for the professionals to study.

Tonny went into some detail describing a WZ-Sge light curve that had been collected by a
group of amateurs. He highlighted the first 9 days of the outburst, and explained how high
quality data can reveal information about such a star of great interest to the professionals. He
used data from the next 11 days to show how to extract period information using his program,
Peranso, and demonstrated it working in real time. A lot of interesting stuff can be dug out of
this data by detailed analysis. He used the next 12 days of the data to show how to extract
information about negative superhumps.

He then moved on to listing the recipe for success in Pro-Am collaboration, which was
summarised as follows:

• Build up your credentials by doing good work, not necessarily in CCD photometry.
• Become a member of a Pro-Am team
• Learn the ins and outs of the objects of interest (TOO’s)
• Practice, exchange and compare results with other amateurs before submitting to the
professionals

Regarding the observation side, he emphasised the importance of high quality, averaged,
flat-fields, and suggested that the observer should consider carefully the value of binning;
exposure times should be optimised, and colour effects must be carefully considered, especially
at low altitude. Unless a project demanded the use of filters, then he felt it was better to take
unfiltered images in order to collect more photons.

When planning data reduction, the trade-offs between aperture and PSF-based photometry
should be carefully considered. Software is available, including the simple, but limited AIP4WIN and the more complete MIRA A/P and IRAF. Tonny discussed aperture photometry in some detail, reminding his audience of the importance of optimising circle size to maximise S/N and having close comparison stars.

The next topic was another case study, this time on the photometry of RR Lyrae type variables. The Blazhko effect (long period amplitude modulation of the light curve) has no sound physical explanation yet, and the professionals are very much interested in good data relating to this. The key, as usual, is to collect lots of high quality data.

Another example of a useful project is exo-planet photometry. There are Pro-Am partnerships available here: in particular see transitsearch.org. The main challenge in this area, was both managing to catch a transit, and the small degree of the modulation, which was typically 10-20 milli-magnitudes. Tonny went into some detail describing the difficulty of achieving the required accuracy (he under-emphasised that in the opinion of this reviewer!). The data reduction is even more demanding. He showed a plot of a transit of HD209458 to illustrate what could be obtained.

Next was NEA’s (near earth asteroids) including binary asteroids. There are many good examples of Pro-Am partnerships in this area. There are also tumbling asteroids, fascinating light curves here. A program called Binary Maker is available to amateurs to study these. The challenge with many of these objects is that they move quickly!

To conclude the talk, Tonny showed us some pictures of his remotely controlled CBA observatory in Belgium which can run all night long without human interaction. With that set-up he has, so far, obtained 220,000 images, making up 165 full days of photometry - an impressive tally!

The CBA website is: http://cba.phys.columbia.edu. Tonny gave a really excellent and useful talk. This review must necessarily be just a brief summary of it: Any amateur wanting to get involved with a Pro-Am project would be well advised to review his talk when it is made available on the web pages in the near future.

Nick James then spoke on the topic of Cometary Photometry - A difficult challenge. He made the introductory observation that comets are difficult because they are not point objects. To illustrate this, he showed a beautiful image from 1996 of comet Hyakutake showing a bright nucleus, an extended coma and a very extended tail.

There are two common definitions of comet magnitude currently used by visual observers:
• $m_1$ is supposed to be the magnitude of the coma excluding the tail; difficult to be exact because the coma goes down to the sky background and that varies from place to place anyway.
• $m_2$ is the nuclear magnitude - but where does the nucleus end and the coma begin? A 10 arc-sec aperture is commonly used.

A further complication is introduced if considering the effects of filtering, as the various emission lines will give different answers with different filters and this complicates the issue a lot. The whole thing is a mess! It seems that neither of the above definitions is therefore really suitable for CCD work.
At the MACE 2000 meeting, Mark Kidger had suggested a compromise for CCD observers based on using an unfiltered image and a fixed aperture. Nick suggested the following key points be observed:

The key points to consider when obtaining a suitable image:

- For bright comets, filters must be used to get consistency and either Johnson V or Cousins I, properly calibrated for the CCD, are suitable.
- Use correct focal length to allow a complete coma and sufficient surrounding sky
- For large bright comets a short focal length is necessary
- The exposure must be long enough to give a good SNR but without saturating the coma
- Defocusing can be used but the same focus must be used for the comparison star(s)
- Always defocus if undersampled
- Accurate image calibration is essential (flats, biases, darks etc)
- Instrument
- For determination of m1, use a short focal length so that the coma fits
- Sometimes a comet is so large that a short focal length camera lens is best

When it came to the determination of the aperture diameter, agreement was needed on a standard size. One possibility would be to use a constant physical size at the distance of the comet eg: 100,000km at the comet, 2 arc-min at 1au, 20 arc-min at 0.1au, although this could prove tricky if the comet gets very close.

When it came to measuring the image, stars in the coma must be removed before analysis or they would lead to errors. In most image processing software, this can be done manually eg the IRIS MAX command. The sky background should be determined using a median algorithm, and the integrated counts in the aperture must be measured and the background subtracted.

Why make Life Difficult? Nick argued that we should not be attempting to emulate m1 and m2 but should think seriously about following Mark Kidger’s suggestion, and use a standard aperture, probably a 10 arc-sec one, which for large comets is in fact about m2.

To reduce scatter, a large number of reference stars is a good idea using, for example, Astronomica and USNO A 2.0 or B 1.0. Without great care the scatter between measurements from different observers can be as high as 5 magnitudes! With care this can be reduced to about one magnitude.

Nick summarised by saying that CCD comet photometry is difficult if we try and emulate the m1 and m2 measures, but good results can be obtained if we use a standard aperture which, at least, gives internally consistent results.

The next speaker was Richard Miles talking about Asteroid Photometry. Amateurs can make a significant contribution towards collecting data on asteroids, and some of this data can be used to gain further scientific insights about the composition and history of these objects and thus provide more data about our solar system and its evolution.

Richard outlined some topics that were potentially useful for Pro-Am collaboration, as listed overleaf. Those marked with an asterisk were explored further:
Richard enthused about the excitement of asteroid photometry and encouraged his audience to *Get over the activation energy barrier!*

Richard covered some facts on rotation: apparently of the thousands of asteroids known, only 1700 have known rotation rates (2.2% of numbered ones) so there is a lot left to do. 72% have an amplitude of 0.1 to 0.5%; 52% have periods of 2-9 hours; the shortest period is 78 seconds; and 11% have periods of over 24 hours, which is difficult to observe. In particular, getting more data at the extremes, those that rotate unusually slowly or quickly, is particularly valuable scientifically.

Richard listed the basic techniques for obtaining rotation light curves including the necessity of obtaining lots of images; whether to use no filter, or use V, R, I filters, the importance of good flats and darks; image reduction; how to check for the possibility of contaminating faint stars by stacking images; using multiple comparison stars for photometry, and plotting differential magnitude vs time.

One of the easy things about asteroids compared to variable stars, is that they only reflect sunlight, so colour effects are negligible, hence good measurements can be made under poor (typical UK?) skies. As an example Richard showed raw data on 656 Beagle showing a 2 magnitude irregular variation. After processing, this became a beautifully smooth rotation curve. Richard emphasised the importance of stacking to identify faint stars on the track. Frames that include stars in very close proximity can then be ignored in a simple approach, although it is possible to compensate for them with a little extra effort.

Richard briefly discussed binary systems with reference to DP107 and 1089 Tama. The latter is a tidally locked system and the light curves show occultation and shadowing effects.

*If you really want to understand asteroids you must get to know phase curves!* It is important to make measurements at low phase angles, and then follow the object of interest around the sun to begin to get information about the surface constituents of the object. A lot more data is needed in this area. Richard said that he had begun to do a lot more work at low phase angles this year. He showed a plot containing a lot of information taken by a group of observers over just 8 days near the opposition of 656 Beagle.

Amateurs can help with co-ordinated observation programmes to catch Near Earth Asteroids whilst they are close by. This is not an easy project because of the rates of movement.

Richard finished by showing pictures of his new observatory containing an 11" SCT which fits into just one and a half cubic metres.
Roger Pickard then gave an introduction to the idea of the *The VS CCD Target List*. This programme is to assist and guide newcomers to CCD observing. All the details are on the VSS website. There are four levels of difficulty represented in the projects:

**Level 1: Basic, for those not using filters**  
V1363 Cyg, 1454 Cyg, Cg Dra, V650 Ori

**Level 2: Good timing of data required, no filter required**  
ES Dra, KV Cas, LL Lyr TZ Per

**Level 3: Approximate differential photometry, use of at least one good filter required, but no transformations necessary**  
NSV 2249, HV Aqr, HT Cas, GO Cnc, NSV 4031

**Level 4: Precision Differential Photometry, use of good filters, with correct transformations being applied**  
SS Cyg, VZ Cam, CO Uma, AT Dra, GY Cnc

The comparison stars to go with these are in two groups, those brighter and those fainter than magnitude 11.

The first group are all taken from Tycho. All the positions are J2000.0, and the photometric data is Tycho Vj. Three comparison stars are given for each, although only two are necessary. Roger showed a list for one of the target stars, AT Dra.

Data for comparison stars for those fainter than magnitude 11 are mostly taken from Arnie Henden's data set. Some of these stars are not in the GSC so charts are provided for them. Roger showed a list for CG Dra.

Roger introduced another list for those looking for a quick fix! This is based on the BAA VSS selected bright fast EB's, with magnitudes 9-10, and periods from 0.35 to 0.99 hours. With these you can get a result and a nice light curve within a few hours.

Roger mentioned that the VSS Mentoring scheme for visual observers has been extended to CCD observers. For more details contact Karen Holland.

David Boyd then gave a presentation on the reporting side of the *CCD Target List* scheme. There are three main aims:

1. To create a consistent record of the extracted data, and all necessary information about a CCD photometric observing session  
2. To quickly check that the data is problem free  
3. To automatically generate report files

David set up an Excel spreadsheet to do this, which has become the CCD Template (see page 6 of this circular for more details). He showed an example of the spreadsheet and how to input data, which I cannot reproduce in this review but it looked pretty straightforward!

Andy Wilson then went through some details on entering data to the template, which is
designed to make that process as easy as possible. Again all I can say about that is that it looked good!

Roger then came back and discussed plans for the future, which included

• Work to get data into a centralised database
• Produce a retrievable database and ensure long term safety of the data
• Eventual aim is a web-accessible data-base, perhaps available through the Astrogrid system

Roger noted that there are now many CCD articles in the VSSCs, and commented that we (the VS) want feedback - how can we help more, are we doing the right things?

The final question was: Do we want another CCD Meeting next year?
Answer: YES!

**IBVS 5441-5488**

Gary Poyner

5441 **AY Lacertae** is a cataclysmic variable. (Kroll et al, 2003)
5442 A new double mode high amplitude delta Scuti star **GSC 2583-00504** (Wils et al, 2003)
5443 Photoelectric minima of some eclipsing binary stars. (Gurol et al, 2003)
5444 Period change in an RS CVn binary - what drives **CF Tuc**? (Innis et al, 2003)
5445 Multicolour observations of the primary and secondary eclipses of **OW Gem**. (Mikolajewski et al, 2003)
5446 Elements for 5 variable stars. (Haussler et al, 2003)
5448 On two unstudied large amplitude variables **DT Sco** & **DV Sco**. (Pastukhova & Samus, 2003)
5449 Brightness variations of **SAO 84309**. (Robb et al, 2003)
5450 **V597 Scorp** and it’s neighbour: A double Mira star? (Samus & Hazen, 2003)
5451 Photometry of **HR 1817** at two sites well seperated in longitude. (Budding et al, 2003)
5452 New SX Phe variables in the innermost region of M15. (Kravtsov & Zheleznyak, 2003)
5453 The R band light curves of eclipses of **U Gem** in outburst. (Simon, 2003)
5454 Optical spectrum of **CI Aql** in the plateau phase. (Matsumoto et al, 2003)
5455 Seven new eclipsing binary stars among the FASTT1 variables. (Garcia-Lastra et al, 2003)
5456 Times of minima of eclipsing binary systems **DO Cas, V1143 Cyg, GO Cyg** and **VW Cep**. (Dariush et al, 2003)
5457 Confirmation of variability of Bidelman-Macconnell suspected variables. (Wils, 2003)
5458 Confirmation of variability of FASTT suspected variables. (Greaves & Wils, 2003)
Revised [Fe/H] and radial velocities for 28 distant RR Lyrae stars. (Pier et al, 2003)
Discovery of two new dwarf novae in Cepheus and Cygnus. (Antipin & Kroll, 2003)
Photoelectric minimum times of some eclipsing binary stars. (AK & Filiz, 2003)
Photoelectric minima of some eclipsing binary stars. (Muyesseroglu et al, 2003)
New times of minima of some selected eclipsing binary systems. (Bakis et al, 2003)
The gamma Doradus variable **HD 19684** - a spectroscopic binary. (Kaye & Fekel, 2003)
On the possible 9-day periodic variability of **DI Cep**. (Ismailov, 2003)
A CCD photometric search for pulsations in **SZ Her**. (Szekely, 2003)
Detection of magnetic field variations over the pulsation period of the roAp star Gamma Equ from Fe II 6149 line. (Savanov et al, 2003)
CCD photometry of DT UMa, V672 Her, V868 OPn and GSC 3135 0673. (Pejcha et al, 2003)
Minimum times of several eclipsing binaries. (Deeg et al, 2003)
Photoelectric minima of some eclipsing binary stars. (Selam, et al 2003)
**GSC 2139 2190** is a slowly changing BE variable and not a hot low mass post asymptotic giant branch star. (John Greaves, 2003)
Observations of the dwarf nova **X Leonis**. (Spogli et al, 2003)
New variable star in the filed of **EM Cygni**. (Spogli et al, 2003)
**NSV 25610**: A high amplitude delta Scuti star. (Wils et al, 2003)
Photoelectric minimum times of some eclipsing binary stars. (Bulut & Demircan, 2003)
Optical CCD observations of **Eta Carinae** at La Plata observatory. (Fernandez et al, 2003)
Six suspected variable stars identified as Asteroids. (Bedient, 2003)
Limits on pulsations in two eclipsing binaries: **AY Cam & RW CrB**. (Derekas et al, 2003)
New elements for 80 eclipsing binaries. (Otero, 2003)
Four RR Lyrae stars with variable periods in Ophiuchus. (Haussler et al, 2003)
Hipparcos eclipsing binaries showing apsidal motion. (Otero, 2003)
A revised period for the Mira variable **AW Aurigae**, (Templeton, 2003)
Photoelectric minima of selected eclipsing binaries, (Agerer & Hubscher, 2003)
Photolectric maxima of selected pulsating binaries, (Agerer & Hubscher, 2003)
The first complete CCD light curves and orbital periods change of **IK Per**. (Zhu et al, 2003)
Times of minima of eclipsing binary stars. (Lacy, 2003)
Superhumps in the 2003 **UV Per** superoutburst. (Price et al, 2003)

The Information Bulletin on Variable Stars (IBVS) can be accessed through the WWW in HTML format at the following URL.... http://www.konkoly.hu/IBVS/IBVS.html
SOURCES OF SCATTER AND ERROR (PART 4)

TONY MARKHAM

Environmental Factors

Light Pollution

Light pollution reduces the darkness of the sky background, reducing the limiting magnitude that can be seen when using a particular instrument. In addition, individual sources of light pollution can cause glare when a variable is nearby in the sky. Sources of light pollution that are directly visible from the observing site can affect the observer’s dark adaption. The effect of light pollution on the accuracy of variable star estimates depends on the colour of the light source involved. For example, the orange glow from low pressure sodium lighting will cause red variables to appear fainter relative to their whiter comparison stars than they would in skies free from light pollution.

Change of Observing Site

Although it might seem like a good idea to occasionally observe from a location free from light pollution, bear in mind that this will probably introduce jumps in the estimated magnitudes for many variables, due to the change in the colour of the sky background from that of your usual observing site. The Position Angle effect can also be a factor, if at your alternative observing site you find yourself viewing the field of view in a different orientation from that which you normally would.

Thus, although it might be suggested that you take your binoculars on holiday with you so that you can make observations, this might in practice increase the scatter in your brightness estimates, but this would still be better than no observations at all.

Twilight

For many variables there will be certain times of the year, before and after conjunction with the Sun, when they are only observable in twilight. In these circumstances, an observation made under these less than ideal circumstances can still be better than no observation at all.

Several factors come into play, in this case:

• The variable and comparisons will be seen against a sky background that is not as dark as usual (and red variables appear brighter relative to whiter comparison stars when observed against a bright background, than when observed against a dark background)
• The variable will be closer to the limiting magnitude and thus less easy to see
• The observer will not be fully dark adapted, and so is likely to be using mesopic rather than scotopic vision.

Moonlight

The effect of moonlight is similar to that of twilight, with mesopic vision taking over from scotopic vision in bright moonlight. Fortunately, moonlight will only be a problem for part of each month. This can be mitigated by making observations at times when the moon is not in...
the sky, either at a different time of the night, or on a different night. Sometimes, however, this is not feasible, especially when observing rapidly changing variables, or when local weather conditions typically mean that only a few nights are available for observing each month. In any case, analysers of variable star observations need to be wary of apparent low amplitude periodicities of about a month, as these could simply have been spuriously introduced by the changing brightness of the sky background during the moon’s monthly cycle.

**Aurorae**

For observers in high geomagnetic latitudes, aurorae can affect the accuracy of estimates. This effect depends on the brightness and colour of the display, as well as on the auroral forms present (glows, arcs, rays) in the area of sky containing the variable. Often, delaying the observation until the auroral form moves away, or the aurora itself dies down, is a solution. However, major displays may last all night, and this will need to be noted when recording the brightness estimate.

**Cloud**

The problem with cloud is obvious - it dims the apparent brightness of a variable and/or its comparison stars. In general, observers will refrain from making observations through cloud, unless the variable is of immediate interest (e.g. a nova or dwarf nova outburst), or when skipping the observation would leave a significant gap in the observer’s own light curve. However, when there is broken cloud there is the risk that a patch of thin cloud may affect the area of sky containing the variable, and the observer might not readily recognise this.

**Haze, Mist and Fog**

These will dim a variable and its comparison stars, the effect being greater at lower altitudes. They can cause additional problems for observers in urban areas by scattering the glow of streetlighting across more of the sky.

**Altitude Factors**

When observing variable stars or comparison stars that are low in the sky, the observer is looking through a thicker layer of atmosphere than when observing them when they are at higher altitudes. The greater thickness of atmosphere absorbs more light from the star and hence it appears dimmer. The solution is to use comparison stars that are at the same altitude as the variable whenever possible. Although some books do give correction factors for altitude, these should not be used, as they only apply under perfect atmospheric conditions and are incorrect under more typical atmospheric conditions.

An additional altitude-related problem, is that the thicker layer of atmosphere lower in the sky will absorb blue light more readily than red light (hence the red colour of the setting sun). Thus, as a variable sinks towards the horizon, the atmosphere will absorb less of its red light than it will for a non-red comparison star.
Seeing

*Seeing* is a term well-known to planetary observers, and affects the ability to see detail on the planets. If the local atmosphere is unsteady, or if the telescope is significantly warmer than the surrounding air, then the image shimmers and detail is difficult to see. Poor *seeing* also affects variable star observing, causing stars to twinkle strongly. The effect is to cause variables and their companions to repeatedly appear to fluctuate in brightness by many tenths of a magnitude, making accurate estimates impossible. In such circumstances, there is rarely any point in making estimates, and it is a case of waiting to see whether the *seeing* improves later in the night (as it does in many cases).

Instrumental Factors

Quality of Optics

Obviously good quality optics aid accurate brightness estimates. Defects in the optics producing non-sharp images of stars or ghost images of nearby bright stars will reduce the accuracy of observations. If you’ve bought an expensive telescope, then don’t downgrade its effectiveness by using cheap low quality eyepieces!

Remember that quality of optics also includes the eyes of the observer. Defects such as short sightedness can be corrected by adjusting the focussing of the telescope or binoculars, but other factors such as *floaters* in the eye can still affect the accuracy of brightness estimates.

Cleanliness of Eyepieces

It is important to keep eyepieces clean. If they get dirty then the brightness of a variable and its comparison stars will depend on where they are located within the field of view.

Steadiness of instrument

If the instrument is not kept steady (e.g. when using handheld binoculars or when observing in windy conditions), this affects the ability to see the faintest stars and hence the ability to make accurate estimates.

Colour Sensitivity of the instrument

As has already been mentioned, there can be systematic differences between observers in brightness estimates, due to the colour sensitivity of the eyes varying from observer to observer. This can be compounded by differences between the colour sensitivity of different instruments. However, provided that the observer always uses the same instrument when observing a particular variable, the effect of this should be fairly constant and thus will be a systematic difference that can be taken into account when analysing observations.
Stellar Factors

Location of Comparison Stars

Ideally comparison stars should be located reasonably close to the variable, as if it takes time to locate the comparison after noting the brightness of the variable, the accuracy of the memorised brightness can quickly deteriorate. In most cases there will be sufficient comparison stars nearby. Problems can occur, however, when observing the brightest binocular variables (i.e. 4th and 5th magnitude) as potential comparison stars are likely to lie outside the field of view when observing the variable.

Star Colours

If all stars were the same colour, this wouldn’t be a problem. However, not all stars are the same colour. Variable stars are often red, but red stars often make unsuitable comparison stars because so many of them are variable to some extent. Accurately comparing the brightness of two light sources is harder when they are of different colours, than when they are of the same colour. Further difficulties arise in novae, when most of the light output is produced by a small number of emission lines.

Comparison Star magnitudes

The comparison star magnitudes quoted on charts have been derived from a variety of sources. Some charts use comparison star magnitudes based on visual estimates; others are based on magnitudes quoted in star catalogues. Some charts use V magnitudes for comparison star magnitudes; others try to correct them to try to make them match the eye’s visual response to different colours. Such corrections typically use some formula based on a combination of the V magnitude and the star’s colour index (the difference between its B magnitude and V magnitude). As a result, the comparison star magnitudes quoted may differ between the charts of different variable star organisations. As time has passed and photometry has become more accurate, the catalogued magnitudes of some stars have had to be corrected and this is still an ongoing process.

If the comparison star magnitudes are incorrect then this will lead to increased scatter in the observations made. This will, in turn, make it difficult to correct for systematic differences between observers, as the correction will change when the observer changes the comparison stars used as the variable brightens or fades.

The problem with comparison star magnitudes can be most serious for very red stars as their strong colour index will lead to large differences between their V magnitudes and their visual magnitudes. This has now been recognised as a serious problem and many variable star organisations now have a policy of not using comparison stars with such large colour indices. However, older charts may still contain such problematic comparison stars.

Fortunately, older observations which used problematic comparison stars can be adjusted as long as the observer reported the light estimate as well as the deduced magnitude. Unfortunately, not all variable star organisations encourage their observers to record the complete light estimates.
Estimates made using Different Comparison Stars

In general, it is better to always use the same comparison stars when the variable is around a particular magnitude, rather than to use certain comparisons on one occasion and different comparisons on another occasion. The scatter in the observations of an individual observer will be greater if the observer unnecessarily switches between comparison stars.

Multiplicity of Comparison Stars

In some cases a comparison star will have a close companion, which isn’t resolved as a separate object at low magnifications. However, at higher magnifications, the comparison star will appear elongated, and thus fainter than its listed magnitude. Usually, this will merely increase the scatter between observers, as an individual observer is likely to always use the same instrument and magnification when the variable is at around that brightness.

Variability of Comparison Stars

This can prove a disaster, if, after a variable has been observed for many years, it is found that one of the commonly used comparison stars varies significantly in brightness, and there is no record as to which brightness estimates made use of this comparison star. The problem can be significantly reduced by encouraging observers to report their full light estimates, rather than just reporting the deduced magnitude. In such circumstances, the affected estimates can be removed from the light curve, or if the Pogson Step method was used, it may be possible to recalculate the deduced magnitude based on the other non-variable comparison stars used on each occasion.

In practice, a decision has to be reached regarding how much variability can be tolerated in a comparison star. Since visual estimates are accurate to the nearest tenth of a magnitude (at best), variability by a few hundredths of a magnitude in a comparison star can be ignored, especially if the alternative is to use a different comparison star, which due to its colour or its distance from the variable might introduce greater levels of error.

Nearby astronomical objects

Not all variable stars are conveniently located. Sometimes it will be the case that the variable and/or a comparison star is located close to a bright star and the glare from this star makes it difficult to assess the brightness of the variable or comparison. As long as the same comparison is used for a series of observations, this need not be a major problem, although it will probably lead to systematic differences between the estimates of different observers. In some cases, it may be possible to keep the nearby bright star outside of the field of view by using a higher magnification.

A different situation arises when the nearby bright object is moving from night to night. Variable star fields near the ecliptic will be, from time to time, visited by planets. Planets such as Mercury, Venus and Mars will pass by quickly, but slower moving planets such as Jupiter and Saturn may remain a problem for several weeks or even months.
Testing your accuracy

You can use the fact that Cepheid and Eclipsing variables are highly predictable to give yourself an idea of the accuracy of your own observations. There will always be some scatter in light curves based on visual estimates, but it can informative to see how brightness estimates that you believed to be good observations, are sometimes not as accurate as you believed at the time; such knowledge can be useful when making future observations, both in terms of being aware of the causes of errors, and also in avoiding deriving too many conclusions from single brightness estimates.

Simply choose such a variable with an amplitude of less than a magnitude that can easily be observed using your method of observation, and make a brightness estimate of it during each observing session. At a later date use the published ephemerides to calculate the predicted phases at the time of each observation. Then plot a light curve. The results can be rather disturbing - although the general shape of the light curve should be readily visible, the scatter of individual brightness estimates may take you by surprise. Sometimes the most stray estimates can be explained by poor sky conditions at the time, but sometimes an estimate that you recorded as class 1 will be displaced by several tenths of a magnitude from the magnitude of other estimates at that phase.

The fact is that everyone makes mistakes sometimes, even the most experienced observers. This should always be taken into account when considering reports of unusual activity seen by only one observer.

Most observers probably believe their brightness estimates to be more accurate than they really are. Observers sometimes announce a change in visual brightness estimates of 0.1 magnitudes as being a brightening or a fade of the variable, but it is generally not realistic to draw such conclusions given the uncertainties in individual brightness estimates. Although it is possible to visually detect brightness differences between stars of less than 0.1 magnitudes, individual brightness estimates are likely to be accurate to the nearest tenth of a magnitude at best, and under less than ideal conditions can be considerably less accurate. Indeed, bearing in mind the comments made earlier about systematic differences between observers for red variables, it is probably better to refer to consistency rather than accuracy of estimates.

In Summary

Although we have seen that there are many potential causes of scatter and error, brightness variations can nevertheless be followed. When interpreting brightness estimates, however, it is important to be aware of the limitations of whatever method of observation has been used and thus to avoid drawing inappropriate conclusions.
# BINOCULAR PRIORITY LIST

**Melvyn Taylor**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Range</th>
<th>Type</th>
<th>Period Chart</th>
<th>Variable</th>
<th>Range</th>
<th>Type</th>
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<td>8.0-8.9</td>
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ECLIPSING BINARIES PREDICTIONS
TONY MARKHAM

The following predictions, based on the latest Krakow elements, 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 UT, with a value greater than 24 indicating a time after midnight. D indicates that the eclipse starts/ends in daylight; L indicates low altitude at the start/end of the visibility; and << indicates that mid-eclipse occurred on an earlier date.

Thus, for example, on Oct 3, U Cep D18(21)26 indicates that U Cep will be in mid-eclipse at approx 21h UT (22h BST). The eclipse will be observable between approx 18h UT on Oct 3 and 02h UT on Oct 4, with the start of the eclipse having occurred during daylight. Please contact the EB secretary if you require any further explanation of the format.

The variables covered by these predictions are:

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<tr>
<th>Variable</th>
<th>Magnitude</th>
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<tbody>
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<td>8.0-10.08V</td>
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<tr>
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<td>9.44-12.23V</td>
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<td>U Sge</td>
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<td>Z Vul</td>
<td>7.25-8.90V</td>
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Note that predictions for RZ Cas, Beta Per and Lambda Tau can be found in the BAA Handbook.

No long period eclipsing variables have eclipses due during this interval.
2004 Nov 11 Thu  
X Tri    03(05)06L  
RS CVn   03(09)06D  
U CrB    L04(04)06D  
Z Dra    04(06)06D  
TX UMa   D17(15)18L  
Y Psc    D17(16)20  
Z Per    D17(18)23  
SS Cet   L18(17)22  
HU Tau   L18(15)19  

2004 Nov 12 Fri  
X Tri    02(05)06L  
Z Vul    D17(12)18  
Z Dra    D17(15)17  
U Cep    D17(18)23  

2004 Nov 13 Sat  
X Tri    01(04)06L  
TV Cas   04(08)06D  
TW Dra   D17(15)20  
RW Tau   D17(17)22  
SW Cyg   D17(19)25  
U Sge    D17(19)22L  
HU Tau   L18(17)20  
Z Dra    21(24)26  

2004 Nov 14 Sun  
X Tri    01(03)06  
U CrB    D17(15)19L  
TX UMa   D17(17)18L  
Z Per    D17(19)24  
S Equ    D17(20)23L  
SS Cet   L18(16)21  
Z Vul    18(23)23L  
TX UMa   L20(17)22  
TV Cas   24(28)30D  
X Tri    24(26)29  

2004 Nov 15 Mon  
U Cep    01(06)06D  
Z Dra    06(08)06D  
HU Tau   L18(18)22  
X Tri    23(26)28  

2004 Nov 16 Tue  
RS CVn   L01(05)06D  
TW Dra   06(11)06D  
Z Dra    D17(17)19  
TV Cas   19(23)27  
X Tri    23(25)28  

2004 Nov 17 Wed  
U Cep    D17(18)23  
TX UMa   D17(18)18L  
Z Per    D17(21)25  

SS Cet   L18(16)20  
HU Tau   L18(19)23  
TX UMa   L20(18)23  
X Tri    22(24)27  
Z Dra    23(25)28  

2004 Nov 18 Thu  
SW Cyg   03(09)03L  
U CrB    L03(02)06D  
SW Cyg   L05(09)06D  
TV Cas   D17(19)23  
X Tri    21(24)26  

2004 Nov 19 Fri  
Y Psc    00(05)01L  
TW Dra   01(06)06D  
RW Tau   02(06)06D  
Z Vul    D17(21)22L  
HU Tau   L18(21)25  
X Tri    21(23)26  

2004 Nov 20 Sat  
U Cep    01(06)06D  
U Sge    D17(14)19  
TV Cas   D17(14)18  
Z Dra    D17(18)21  
TX UMa   L20(20)25  
X Tri    22(22)25  

2004 Nov 21 Sun  
RS CVn   L01(00)06  
U CrB    D17(13)19  
S Equ    D17(17)22  
HU Tau   18(22)26  
X Tri    19(22)24  
RW Tau   20(25)29  
TW Dra   20(25)30D  

2004 Nov 22 Mon  
Z Dra    01(03)05  
TV Cas   06(10)06D  
U Cep    D17(17)22  
SW Cyg   D17(22)27L  
X Tri    19(21)24  
Y Psc    19(23)25L  

2004 Nov 23 Tue  
TX UMa   D17(21)17L  
U Sge    17(23)22L  
SS Cet   L17(15)19  
X Tri    18(20)23  
Z Per    18(23)28  

2004 Nov 24 Wed  
TV Cas   01(05)06D  
Z Vul    D17(19)22L  
RW Tau   D17(19)24  
TW Dra   D17(21)26  
X Tri    17(20)22  
U CrB    18(24)19L  
Z Dra    18(20)23  
S Equ    22(27)22L  

2004 Nov 25 Thu  
U Cep    00(05)06D  
U CrB    L03(00)05  
RS CVn   D17(19)17L  
X Tri    D17(19)21  
TV Cas   21(25)29  
HU Tau   21(25)29  

2004 Nov 26 Fri  
RS CVn   L00(<<)01  
Z Dra    02(05)06D  
Y Psc    D17(17)22  
X Tri    D17(18)21  
SS Cet   L17(14)19  
TX UMa   L20(23)28  
Z Per    20(25)29  

2004 Nov 27 Sat  
SW Cyg   06(12)06D  
SW Cyg   D17(12)18  
RW Tau   D17(14)18  
TW Dra   D17(16)21  
U Cep    D17(17)22  
X Tri    D17(18)20  
TV Cas   D17(20)24  
HU Tau   22(26)30  

2004 Nov 28 Sun  
U CrB    05(10)06D  
S Equ    D17(14)19  
X Tri    D17(17)19  
Z Dra    20(22)24  

2004 Nov 29 Mon  
TV Cas   D17(16)20  
X Tri    D17(16)19  
Z Vul    D17(17)22L  
SS Cet   L17(13)18  
TX UMa   20(24)29  
Z Per    21(26)31D  
HU Tau   24(27)31D  

2004 Nov 30 Tue  
U Cep    00(05)07D  

2004 Dec 1 Wed  
TV Cas   04(07)07D  
TW Dra   06(11)07D  
RS CVn   D17(14)17L  
X Tri    D17(16)18  
U Sge    D17(17)21L  

2004 Dec 2 Thu  
TV Cas   02(07)07D  
TW Dra   03(07)07D  
U Sge    21(26)21L  

2004 Dec 3 Fri  
TV Cas   02(07)07D  
TW Dra   22(26)31D  
Z Dra    21(24)26  

2004 Dec 4 Sat  
TV Cas   03(07)07D  
U Sge    24(29)31D  

2004 Dec 5 Sun  
U CrB    02(08)07D  
RS CVn   03(09)07D  
Z Dra    D17(17)19  
RW Tau   D17(21)26  
TW Dra   21(26)31D  
TX UMa   23(27)31D  
Z Per    24(29)31D  

2004 Dec 6 Mon  
HU Tau   02(06)06L  
Z Dra    06(08)07D  
Z Vul    D17(15)20  
TV Cas   22(26)30  
U Sge    24(29)31D  

2004 Dec 7 Tue  
U Sge    D17(11)17  
U Cep    D17(16)21  

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2004 Dec 8 Wed
Y Psc     20(25)24L
HU Tau    05(09)06L
del Lib   L06(05)07D
RW Tau    D17(15)20
TV Cas    D17(17)21
U CrB     D17(19)18L
S Equ     D17(21)21L
TW Dra    D17(22)27
2004 Dec 9 Thu
TX UMa    00(05)07D
Z Per     01(06)07D
Z Vul     D17(13)18
Z Dra     D17(19)21
RS CVn    L23(28)31D
U Cep     23(28)31D
2004 Dec 10 Fri
TV Cas    D17(13)17
U Sge     D17(15)20L
Z Per     03(07)07L
TV Cas    04(08)07D
U Cep     D17(16)21
2004 Dec 11 Sat
Z Dra     01(03)06
SW Cyg    L04(05)07D
RW Tau    05(10)06L
TW Dra    D17(17)22
Y Psc     D17(19)23
Z Vul     18(23)21L
2004 Dec 12 Sun
TX UMa    02(07)07D
U CrB     L02(06)07D
Z Per     03(07)07L
TV Cas    04(08)07D
U Cep     D17(16)21
2004 Dec 13 Mon
Z Dra     18(20)23
RW Tau    24(28)30L
TV Cas    24(28)31D
2004 Dec 14 Tue
X Tri     03(06)04L
Z Vul     L06(10)07D
TW Dra    D17(12)17
RS CVn    L23(23)30
U Cep     23(28)31D
2004 Dec 15 Wed
Z Dra     02(05)07D
X Tri     03(05)04L
TX UMa    03(08)07D
Z Per     04(09)07L
del Lib    L05(05)07D
Y Psc     D17(13)18
U CrB     D17(17)17L
S Equ     D17(18)20L
SW Cyg    D17(19)25
TV Cas    19(23)27
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X Tri     02(05)04L
HU Tau    D17(14)18
Z Vul     D17(21)21L
RW Tau    18(23)27
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X Tri     01(04)04L
TW Dra    03(08)07D
del Lib    07(13)07D
U Sge     D17(15)20L
U Cep     D17(16)21
TV Cas    D17(19)23
Z Dra     20(22)24
2004 Dec 18 Sat
X Tri     01(03)04L
TX UMa    05(10)07D
Z Per     05(10)06L
HU Tau    D17(16)19
2004 Dec 19 Sun
X Tri     00(03)03L
U CrB     L01(04)07D
Z Dra     04(07)07D
Z Vul     L06(08)07D
TV Cas    D17(14)18
RW Tau    D17(17)22
TW Dra    22(27)31D
RS CVn    L23(19)25
U Cep     23(28)31D
X Tri     23(26)27L
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SW Cyg    L03(09)07D
Z Dra     D17(15)18
HU Tau    D17(17)21
U Sge     18(24)20L
X Tri     23(25)27L
2004 Dec 21 Tue
TV Cas    06(10)07D
TX UMa    06(11)07D
Z Vul     D17(19)20L
Z Dra     21(24)26
X Tri     22(25)27
2004 Dec 22 Wed
del Lib    L05(05)07D
U CrB     D17(14)17L
S Equ     D17(15)20L
U Cep     D17(15)20
HU Tau    D17(18)22
TW Dra    17(22)27
X Tri     21(24)26
Y Psc     22(26)23L
2004 Dec 23 Thu
TV Cas    01(05)07D
Z Dra     06(08)07D
X Tri     21(23)26
2004 Dec 24 Fri
Z Vul     L06(06)07D
del Lib    06(12)07D
U Sge     L06(09)07D
Z Per     D17(13)18
Z Dra     D17(17)19
HU Tau    D17(20)24
SW Cyg    D17(23)25L
X Tri     20(22)25
TV Cas    21(25)29
U Cep     22(27)31D
2004 Dec 25 Sat
RW Tau    01(06)05L
SW Cyg    L03(<<)05
TW Dra    D17(18)23
X Tri     19(22)24
Z Dra     23(26)28
2004 Dec 26 Sun
U CrB     L01(01)07D
Z Vul     D17(17)20L
TV Cas    D17(20)24
Y Psc     21(27)23L
HU Tau    17(21)25
X Tri     19(21)24
2004 Dec 27 Mon
Z Per     D17(14)19
U Cep     D17(15)20
U Sge     D17(18)19L
TX UMa    L17(14)19
X Tri     18(20)23
RW Tau    20(25)29L
2004 Dec 28 Tue
TW Dra    D17(13)18
TV Cas    D17(16)20
Z Dra     D17(19)21
X Tri     17(20)22
HU Tau    19(22)26
2004 Dec 29 Wed
RS CVn    02(09)07D
del Lib    L04(04)07D
Z Vul     L05(04)07D
U Cep     06(12)07D
SW Cyg    06(12)07D
S Equ     D17(12)17
SW Cyg    D17(12)18
X Tri     D17(19)22
U Cep     22(27)31D
2004 Dec 30 Thu
Z Dra     01(03)06
Y Psc     D17(15)19
Z Per     D17(15)20
X Tri     D17(18)21
RW Tau    D17(19)24
TX UMa    L17(16)20
HU Tau    20(24)28
2004 Dec 31 Fri
TW Dra    03(08)07D
del Lib    06(12)07D
U Sge     L06(03)07D
Z Vul     D17(15)20L
X Tri     D17(18)20

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SECTION OFFICERS

**Director** Roger D Pickard  
3 The Birches, Shobdon, Leominster,  
Herefordshire HR6 9NG  T:01568 708136  
E:rdp@star.uke.ac.uk

**Secretary** John Saxton  
11 Highfield Road, Lymm,  
Cheshire, WA13 0DS T:01925 758009  
E:lymmobservatory@hotmail.com

**Chart Secretary** John Toone  
Hillside View, 17 Ashdale Road,  
Cressage, Shrewsbury, SY5 6DT.  
T:01952 510794  E:john.toone@dial.pipex.com

**Binocular Secretary** Melvyn D. Taylor  
17 Cross Lane, Wakefield, West Yorks,WF2 8DA  
T:01924374651E:melvyn.taylor@breathemail.net

**Nova/Super nova Secretary** Guy M Hurst  
16 Westminster Close, Basingstoke,  
Hants, RG22 4PP .  
T& F:01256 471074  E:Guy@tahq.demon.co.uk

**Eclipsing Binary Secretary** Tony Markham  
20 Hillside Drive, Leek, Staffs, ST13 8JQ  
T: 01538 381 174  
E:tonymarkham@compuserve.com

**Recurrent Objects Co-ordinator** Gary Poyner  
67 Ellerton Road, Kingstanding,  
Birmingham, B44 0Q3.  
T:0121 6053716  
E:garypoyner@blueyonder.co.uk

**CCD Advisor** Richard Miles  
Grange Cottage, Golden Hill, Stourton Caundle,  
Dorset, DT10 2JP  
T:01963 364651  
E:rmiles@baa.u-net.com

**Circulars Editor** Karen Holland  
136 Northampton Lane North, Moulton,  
Northampton, NN3 7QW  
T: 01604 671373  Fax: 01604 671570  
E: karen.holland@xcam.co.uk

**Webmaster** David Grover  
12 Lonewood Way, Hadlow, Kent, TN11 0JB  
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