



**British Astronomical Association**

## **VARIABLE STAR SECTION CIRCULAR**

**No 122, December 2004**

### **Contents**

New Chart for CZ Orionis .....	inside front cover
From the Director .....	1
An Unreconstructed Visual Observer - an Observer Profile .....	2
Report on the Joint VS/I&I section CCD Photometry Meeting (Part 2) .....	4
An Exo-Planet Transit Search Programme .....	8
Summary of the Recent VSS Officers Meeting .....	22
Binocular Priority List .....	24
CCD Mentoring Scheme .....	25
Eclipsing Binary Predictions .....	25
New Chart for CN Orionis .....	inside back cover

**ISSN 0267-9272**

**Office: Burlington House, Piccadilly, London, W1V 9AG**

## NEWLY ISSUED CHARTS

JOHN TOONE

013-03

15' FIELD INVERTED

CZ ORIONIS

06h 16m 43.2s +15° 24' 12" (2000)

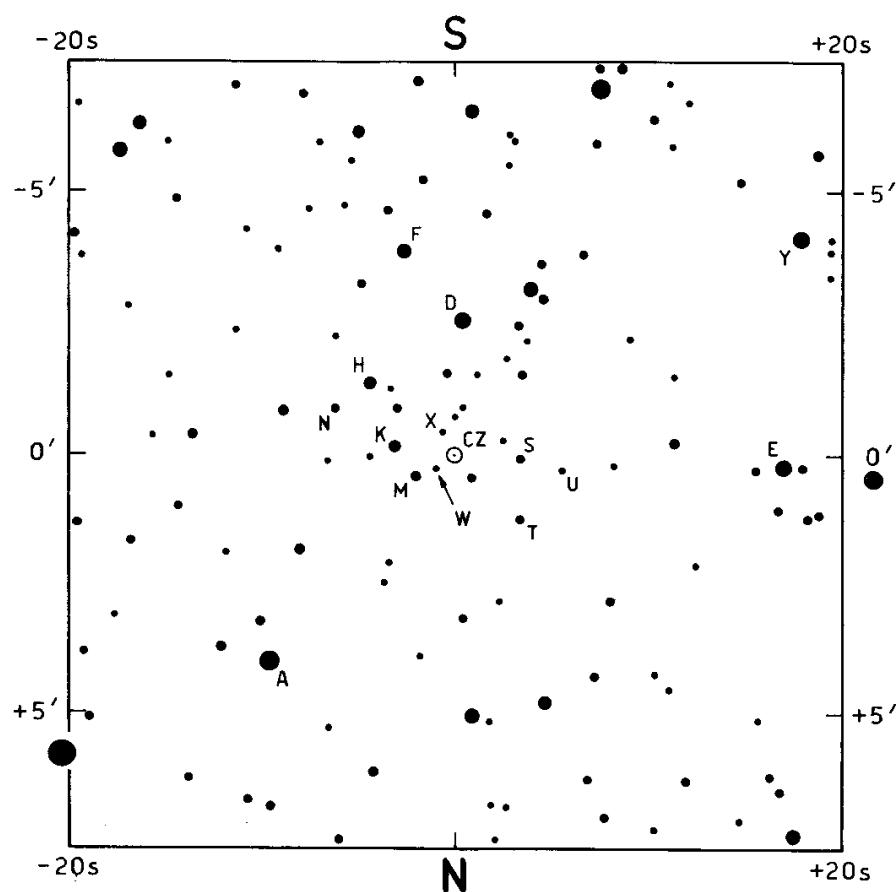


CHART:

DSS IMAGE

SEQUENCE:

A.HENDEN

A 10.6 M 14.6

Y 11.5 N 15.1

D 11.7 S 15.4

E 12.1 T 15.7

F 12.7 U 16.0

H 13.5 W 16.3

K 14.0 X 17.2

BAA VSS

EPOCH: 2000

DRAWN: JT 28-03-04

APPROVED: RDP

## **FROM THE DIRECTOR**

**ROGER PICKARD**

### **Dr Frank Bateson**

Dr Frank Bateson, OBE, FRASNZ, retired at the beginning of December 2004 after 80 years of contributing to New Zealand and international Astronomy. I was therefore delighted when John Toone announced that he would be attending the retirement ceremony, and would be able to personally deliver messages from the President, Tom Boles, and myself.

As a teenager in 1924, Frank Bateson published his first observation of variable stars, whilst in Sydney. In 1927 he joined the New Zealand Astronomical Society, now the Royal Astronomical Society of New Zealand, formed the Variable Star Section, and has been Director ever since. Under his Directorship it has grown to have an international reputation as the principal variable star organization in the Southern Hemisphere. Frank has been recognised with many awards from around the world for his services to astronomy.

His will be a hard act to follow. Congratulations, Frank on a most distinguished career.

### **VSS Meeting at Alston Hall**

For those of you unable to attend this meeting, I regret to advise you that it was probably the best yet! It was a truly excellent long weekend, thoroughly enjoyed by all. Make sure you don't miss the next one, although there are no plans at the moment, it is hoped that this will be in two or three years time, again at Alston Hall. But the meeting wouldn't have been the success it was without the excellent organisational skills of Denis Buczynski and his team, and the many excellent speakers, especially Mike Simonsen, who we worked quite hard. Thank you all. But even if you missed the meeting, you can start to read about it in the next Circular thanks to Melvyn Taylor and Karen Holland who recorded details of all the talks.

### **No charge for charts**

Following a recent discussion amongst the Officers, it has been agreed that charges for charts will be abolished forthwith (although a large SAE will always be welcome, and will speed up delivery). Requests should still be made to the Chart or EB Secretaries as appropriate.

### **Reporting Observations**

Although many observers now report their observations by email, there are still a number who report their observations on paper. Whilst we will always accept observations reported in this way, it would be appreciated if those observers could consider reporting by email (or disc) i.e. that they type up their own observations. This will relieve the small band of helpers who currently undertake this task, to concentrate on clearing the backlog of older observations.

## **AN UNRECONSTRUCTED VISUAL OBSERVER, AN OBSERVER PROFILE**

**MIKE GAINSFORD**

I first became interested in astronomy at a very early age, late in the war, when we lived in Lancashire (only seven miles from Alston Hall, where the 2004 BAA meeting was held). The first astronomy book I can recall, was Ball's *Romance of the Heavens*. This was followed by other books from the library, culminating in Hutchinson's *Splendour of the Heavens*, which was a major stimulus. I can remember my dad buying me George Philip's *Signpost to the Stars*. Along with the usual comics I took *The Children's Newspaper*, which had excellent astronomical articles. At grammar school when I was 11 or 12, a teacher kindly loaned me his 3" refractor. This was on a pillar and claw stand, and, although wobbly, enabled me to observe the summer objects I had only read about, by getting up at 3 in the morning. My parents weren't too happy about this!

When we moved down to Leicester, for successive Christmas presents, I had a Broadhurst and Clarkson 2.25" refractor, and my own copy of *Splendour of the Heavens*. I spent many happy hours chasing Struve objects with the aid of the Cottam's star maps in the back of this book. I now consider this somewhat of an achievement, and it was certainly a very sound grounding in star-hopping. Have a look at these star maps sometime, if you are able. Who needs a *GoTo* facility? But at that time, I thought that variable stars could not possibly be interesting.

National Service, studying, girls, marriage, and a family then meant that astronomy had to take a back seat for about ten years. But as a surveyor in the Royal Artillery, with Suez threatening, two of us (both with astronomical interests) were speedily taught how to do star shots with a theodolite. We used Arcturus, and managed to pinpoint our position on Salisbury Plain to within 3 miles.

My interest was rekindled in 1964 or 5 (possibly stimulated by the nearby Barwell meteorite fall). After much heart-searching as to whether it was right to do this with a young family to look after, I approached the Midland Bank for a £200 loan (!), and got myself a Fullerscopes 8.5" Newtonian. I joined the BAA (although I'd been buying their Handbook for years), and started to observe everything in sight, sending off the results to the various observing sections. I also subscribed to *The Astronomer*, and sent my results there as well. I was on the BAA Council for two years in the early seventies.

In 1996, a number of moderately bright comets appeared, and I was so excited at my first sight of one of these, my first ever comet (Kilston, I think), that I decided to submit estimates of their brightness. How better to do this, but to practice on variable stars? But the practice became an obsession, and today I seldom observe anything else. To date, I have records of around 56,000 VS observations from 1966, but unfortunately, for eleven of these years I have no record. The real total may be more like 60,000.

But I'll never make 'the ton'. At 68, and going at my usual rate of 3000 in a good year, it will take me at least until I'm 81! Age and creeping light-pollution will win, I'm afraid. I shouldn't have wasted all those years on observing Mars, Jupiter, Saturn, meteors and various comets (only joking!).

I now observe with a 10" Newtonian, which I have had for well over 20 years, in a run-off clamshell-type shed which I built myself. I have been lucky enough to achieve most of my astronomical desires. I missed the Leonid storm, but have seen five total eclipses (all clear) some good comets, and a transit of Venus. Jeremiah Horrocks was a boyhood hero when I lived about 5 miles from Much Hoole.

I was a Chartered Civil Engineer, and took early retirement from Local Government in 1990. I was a founder member and am chairman of the Hinckley and District Astronomical Society, and was a founder member of the Leicester AS in 1952. Apart from astronomy, my other main interests are genealogy and classical music. I am a founder member of the Ralph Vaughan Williams Society, and I like real ale.



**The picture above shows Mike, with his wife Barbara (left side of telescope), and some family friends, outside his observatory with 10" Newtonian and run-off shed, which he uses.**

## **REPORT ON THE JOINT VS/I&I SECTION CCD PHOTOMETRY MEETING (PART 2)**

**GARY POYNER AND KAREN HOLLAND**

The Chairman for the Sunday morning session, Bob Marriott, introduced the first speaker of the day, who was **David Boyd** talking about *A VS Section Excel spreadsheet to aid data reduction, a live demonstration in its use.*

David introduced the MS Excel CCD data entry spreadsheet, which was available for CCD observers, and which was an important tool for checking and standardising those observations made with a CCD camera. Although it was now widely in use by UK observers, further design layouts would probably be available in the future.

David described the various entry fields in more detail, showing how they were colour-coded for ease of use. These fields included in-depth information on the CCD (chip, noise etc), filter information, general observer information, information on the star under observation and the check star, sky brightness details and how the spreadsheet read data from AIP4WIN.

An example was shown with the Spreadsheet using data from KV Dra from personal observations, and the procedures for loading data from AIP4WIN were described in some detail. The end result was then displayed as a light curve for the variable and check star. The Summary sheet contained all of the relevant information used when reporting the information. David also showed how the *output* sheet read data from the spreadsheet, and converted it to the AAVSO and BAAVSS reporting formats.

There were a few questions related to uploading data to the AAVSO, and the availability of the spreadsheet; it would be made available to download from the BAAVSS website. Norman Walker suggested that the JD date should be converted to HJD, and there was a discussion about this.

The Chairman thanked David for his presentation, and then introduced the Belgian CCD CBA observer **Tonny Vanmunster** to talk about *A Demonstration of Peranso Software for Time Series Analysis of Lightcurves.*

Tonny started by saying that his presentation on Peranso followed on nicely from David's outline of his MS Excel spreadsheet, in that Peranso took data from other sources such as Excel, text files etc in a similar way. Peranso is, however, a complex and detailed data analysis program with many different functions. Tonny described Peranso in some detail, displaying the Observation, Period and Phase windows, which also included a HJD correction. A light curve was displayed, in order to show how the properties of the graph could be altered. Data from various observers could be entered using a variety of JD and magnitude formats, including multiple observation sets, colour-coded for different observers.

Tonny then gave an example of the operation of Peranso using a large data set for Z UMa from the AAVSO database, which included some 59,000 observations, in which a period determination in a graphic and tabular form was shown. Following this, data on a Delta Scuti star was used to calculate multi-periods and perform a period accuracy check. Peranso also checked the analysis to determine whether the peaks displayed were real or false. A full help

facility and a very handy tutorial was included with the software. Norman Walker suggested several improvements for future releases, but was very impressed with the software as it stood. Richard Miles asked whether Perando could be used for Asteroid work, and Tonny replied that it was suitable for such analysis.

Next, Stan Waterman spoke about CCD photometry in Dense Star fields. This talk was very well received, and many people wished to speak to Stan about his work during the day. As a result of this, Stan has written up his talk as a separate article in this circular (starting on page 8)

After the tea break, Arto Oksanen, who had travelled from Finland specifically for the meeting, gave an introduction to the CCD projects of Nyrolo Observatory. This local society had about 250 members, of whom around 10% were observationally active. Arto showed pictures of some of the domes, and mentioned a new radio telescope project that the group were involved in.

The group's main instruments were 16" and 10" Meade LX200 telescopes, together with an SBIG ST8XE and AO7 adaptive optics device. They had B,V and R filters which were used on a slider. An Optec TCF-S focuser, Optec focal reducer, and a video camera with GPS time-setter for occultation work, all helped to make for a well-equipped observatory, which was completed by a permanent internet connection. All images collected were stored in FITs format on a web server in real time, so that members could access the images collected in real-time.

The first images started to be collected in 1999, initially practising taking images, and rapidly moving on to more scientific work, including the monitoring of CVs, GRBs, blazar-monitoring, the collection of asteroid light-curves, the monitoring of Jovian moons (together with Armagh University) and exoplanet work.

The team appeared to be very dedicated. The eclipsing dwarf nova IY UMa had been observed through every single outburst since it was discovered; WZ Sge had been observed through its recent unexpectedly early outburst; they followed-up Sloan Digital Sky Survey CVs; GY Cnc, an eclipsing dwarf nova of interest was a favorite target, as was the Delta Scuti variable (GSC3693) that they had discovered whilst observing OY Per when it was in outburst on one occasion.

Asteroid light curves were plotted for many asteroids, including the NEO Hermes 2003-10-18 which was originally discovered in 1911, and was lost, only to be rediscovered last year.

The group had spent a considerable amount of effort on exoplanet detection, collecting 900 V-filtered images , each with a 10s integration time towards this project. They had found that scintillation of the earth's atmosphere was a big problem in this field of study. In spite of the fact that the field of view was sufficiently small that they couldn't get the comparison star in the image, they still managed to detect an exoplanet transit of the star HD209458, by averaging many measurements together.

Blazars are a subclass of AGNs, that are billions of light years away. They are thought to have one or more super-massive black holes at their centres. The group had been monitoring 3C66A, at a rate of one image per night, and had also contributed to light curves of the blazar

S5 0716+71 during an international observing campaign.

The group were active supporters of the GRB network. They had a system up and running which sent SMS alerts to members' mobile telephones, so that they could look for afterglows. The first success that they had was in tracking the afterglow of GRB000926 on September 28th, 2000. They followed this by producing multi-colour light curves of fading GRB afterglows, achieving the distinction of being the first amateurs to produce such a lightcurve. Arto also showed an interesting GRB afterglow lightcurve, which appeared to indicate that there was a delay in the red light, compared to the green light, but as Arto had been the only person that was observing this at the time, it was difficult to confirm this unusual effect.

The society had plans to build an 80cm telescope that would be remotely-operable, and they had applied for EU funding to do this.

The next speaker of the day was **James Weightman**, who was talking about **Photometry Experiments with a Digital Camera**. James described how he had been using a digital camera to take pretty pictures of the sky. He had decided to see if he could use it for photometry. His camera was a Canon EOS 300D DSLR CMOS sensor. It had an 85mm f1.2 lens. He used it to obtain some images to try to create a light curve of a simple eclipsing binary, W UMa. He showed a range of images that he had taken using the camera, and the resulting light curve. He felt that, whilst not of fantastic accuracy (the standard deviation on the measurements appeared to be around 0.1 magnitude), he felt that it had been a useful experiment.

Richard Miles commented that it was quite important, in this case, to ensure that the image was defocussed so that it occupied several pixels, as some of the CMOS sensor circuitry occupied part of the chip's area (the fill factor is not 100%). Defocussing to occupy many pixels reduces this effect.

After lunch **David Boyd** talked with a title of **It's Surprising What you can Measure**. David presented his recent work on the CV DO Dra. This system was reported to be in outburst recently, and so he followed the system over a night, and produced a light curve. He removed a low frequency variation which was not the orbital period, by calculating a running average, and this left him with a high frequency modulation. He used Tonny Vannmunster's Perando software to do a period analysis on this remaining signal, and folded the light curve on the spin period of the system. This folding and binning process gave a much clearer indication of the period of the system. He concluded that he had successfully detected the white dwarf spin period, and commented that, if this is the case, then it was the first ever direct detection of the white dwarf spin period in the V band.

Gary pointed out that DO Dra showed interesting behaviour in that it occasionally rose in magnitude up to around magnitude 13, which was not classed as a full-blown outburst, but was only a partial outburst.

Next **Norman Walker** spoke with the title **Amateur Photometry, a Strategy for Survival in the Terabytes per day era of Professional Photometry**. Norman wanted to focus on the areas where amateurs could still compete to do useful original work, in this day of robotic telescopes. He thought that if the professionals really could achieve the 1% accuracy that they hoped to, then this might reduce the numbers of projects available to amateurs, but he felt that the 1% target might not necessarily be achieved. He had made measurements with a

precision of millimagnitude accuracy in the past, and felt that there were lots of potential projects, if amateurs were willing to work to achieve this level of accuracy.

Norman showed a truly weird evolving light curve of Cygnus X1, that he had taken. Apparently no other B supergiant like Cygnus X1 had ever been investigated like this, and he felt that there was a lot of opportunity here.

Solar oscillations, at a level of  $10^{-5}$  were too small a variation to monitor, and pulsars were too faint, but almost all the rest of the universe was up for grabs! Norman went on to describe lots of the interesting projects available for amateurs, especially for CCD precision projects. He was particularly interested in non-radial oscillations that might exist in Mira-type stars. Non-radial pulsations exhibit equally-spaced frequencies, and Norman felt that there was some evidence for this type of behaviour in Miras, which had not been properly investigated to date.

Norman finished his talk by commenting that he felt that the cost of £250 per hour for the use of the Faulkes telescope was too expensive for most amateurs, particularly when you could do good work at home with currently available equipment.

The next speaker was **John Saxton**, who spoke about *CCD Photometry at Lymn Observatory*. Inspired by Don Kurtz's talk at Alston Hall last year, John had decided to monitor the white dwarf ZZ PSc with his CCD camera. He showed his measurements which varied by about a 10th of a magnitude. White dwarf oscillations have very short cycles, of the order of 4 per hour.

John then went on to describe his photometry software that he had developed based on Tim Naylor's Optimal Extraction algorithm. This method used the Signal to Noise ratio in each pixel to weight each pixel for the purpose of photometry. John had used his software to analyse a series of stars in a field, and he had analysed the scatter to compare the results from doing the photometry using different methods (standard PSF and Optimal Extraction).

His trials seemed to indicate that optimal extraction gave a better standard deviation than a soft aperture; he compared the percentage scatter for both techniques. He did find that the optimal extraction technique was the most troublesome for the faintest stars, and he developed a system by which he set the mask using the faintest star, and then used this for all other stars. The difficulty was that the mask was then not optimal for all the other stars. John's work was very interesting, and left us all with a lot to think about!

**Richard Miles** then spoke about the *Calibration of Unfiltered Photometry*. He started by showing some examples of unusual spectra, in order to emphasize the range of targets that was available, which meant that filtering of CCD measurements was essential in almost all measurements.

In addition to the range of targets, CCD responses varied considerably too, and using a filter also reduced the transmission. Most CCD users would choose filters that, when combined with their CCD responses, would ensure that their system approximated to either the Johnson or the Hipparcos systems. Once a filter system was selected, M67 was a favorite target for providing a selection of standard stars for the calculation of transformation coefficients. Richard had done a considerable amount of work to look at the transformation of Landolt V

standards to Hipparcos stars. He went on to say that he felt that his method of using Hipparcos red-blue pairs was a useful one. Although there was only one Hipparcos red-blue pair in M67, there were a great number of others available for use. Richard had examined the Hipparcos catalogue, and had identified many red-blue pairs; they were all bright stars, which meant that the integration times for image acquisition would be short. Richard had acquired these images unfiltered, and had then calculated his transformation coefficients using these. He had used the unfiltered system applying a transformation to the results to obtain a V magnitude, and had used this method for different CCD cameras and felt that it worked very well.

Richard went on to show how atmospheric extinction affected colours, and felt that it was important to determine the dependence on colour of the extinction coefficient. He suggested a number of targets for unfiltered photometry. He suggested that very faint supernovae, and asteroids with reflectance spectra, that show no absorption or emission lines, were suitable targets. He thought that objects that were either very red or very blue in colour were not suitable for this method.

Richard then went on to describe the Linearity Testing Kit that had been developed by John Saxton for testing CCD cameras. The kit was designed to reflect light on to the camera in that same way that a flat field would, but the amount of light was altered by changing the LED's duty cycle. Using this, it was possible to obtain some images, and selecting a nice flat part of the flat field, the linearity measurements could be performed.

He showed the results for several CCD cameras including the Starlight MX916, which had very good linearity; the MX516, which was not quite as linear, but was acceptable for use if restricted to half its dynamic range; and the SXV H8 which had good linearity. Richard commented that he had noticed other subtle effects that appeared to be taking place with microlensed chips, and he stressed that it was important to fully understand these systems in order to perform good photometry with them.

After a brief discussion, the meeting was closed.

Editors note: Richard Miles has written up the aforementioned linearity measurements, and they will be published in a future circular.

# AN EXO-PLANET TRANSIT SEARCH PROGRAM

STAN WATERMAN

## Introduction

This article is a modified version of the talk that I gave at the Pro-am CCD Photometry Symposium on 15/16th May 2004 in Northampton. It covers more topics than the talk (I've included those topics which I hope will be of particular interest or use to people), but in less detail, and is more of an overview of the highlights of the work to date.

## Historical Note

I decided to attempt this project following a talk that was given to my local society in October 2000, which included a mention of the transit of HD 209458. I thought to myself *I could do that!*, and that's how all this work started. If I had known then, what I know now, I rather doubt I'd have started at all! Here is a sentence extracted from a recent email from Tim Brown, who used to run STARE, and is a co-discoverer of the first, recent, and so far only transit discovery, TrES-1. *I had originally supposed that I was going to do this whole project myself, put in a few months, find a bunch of planets, and show the world how easy it was. Well, it didn't turn out that way.*

Anyway, that's now, not then, so I did make a start early in 2001, and although the first two and a half years yielded no useful data, I learnt a lot. All the important elements of the analysis programs were developed during that period, so it was a productive time from that point of view. In the first observing season 2001/2002, I used a 12" reflector with a Starlight Express MX camera, taking images in 30 contiguous areas of the sky in Cygnus on every clear night, for as long as possible. Things have changed a lot since then; I now image one, much larger, area of Cygnus, and collect more data in 2 hours than I used to in the whole of that first season!

## Equipment

For the 2003/2004 season, I used an Apogee AP16E camera with a Takahashi FS128 refractor, and a focal reducer/ flattener to bring it to F/6; this gave me a 2.7 degree square field of view. This season, I've been using a TMB130 F/6 refractor with a field flattener, and the same CCD camera, which gives me the same field of view. Neither telescope is ideal for the job: the Takahashi has a superior image quality over the field compared to the TMB (which was both a surprise and a disappointment), but it has very poor vignetting, which amounts to up to 50% in the corners of my field, a diameter of 52mm, compared to only 10% with the TMB.

## Basic Concepts

The aim of the project remains to detect an extra solar planet by the transit method. What we are looking for is a *Hot Jupiter* similar to the HD209458 system (and indeed to TrES-1), which is likely to give a brightness dip of around 1-2% lasting in the region of 3 hours. That seems a pretty straightforward task on the face of it; the trouble is, there does not seem to be many transits that are suitably aligned and timed for us, so one has to measure a lot of stars.

The other constraint is that you have to measure them for as long a continuous period as possible, and for as many nights as are available. In addition, you need a high data rate to allow good noise-averaging within that approximate time frame of 3 hours. So all this means that you can't go jumping around the sky to get lots of stars, you must stay in the same place. A large field of view is therefore essential, as is a rich target area. My chosen target area is centred at 21 08 30/ 46 30 0. I imaged it from September to January last season, and from mid-August this year up to the current date. After quality filtering, I have 9522 good images from last season and (up to October ) 8,500 so far this season.

### **Data Flow**

- a) Images are collected in Fits format. A good October night can yield 9 hours or 600 images, sadly there are very few good nights in the UK!
- b) The date and time is extracted, and they are converted to APL\* files, dark-subtracted, flat-divided, and a global background is subtracted from the image. At this stage the brightness of the image is assessed, and the background level across it measured. Cloud-affected or otherwise poor images are flagged at this stage.
- c) The first step in the analysis is to find the brightest 6000 or so stars in each image, and measure their approximate brightness and accurate centroids.
- d) Knowing the scale factor, these are then pattern-matched to a set from the same area of sky from the USNO B 1.0 catalogue. An iterative procedure is used to derive the picture coefficients from the co-ordinates of the matching set, there is more detail on that below.
- e) The co-ordinates (RA and Dec) from a pre-made starlist are converted to x and y pixel positions for each image; the images are then probed at those points and a square of pixels centred on each star is extracted. The samples vary from 23 pixels square for the brightest stars, to 13 pixels square for the faintest, with the star centroids in the centre pixel. The approximate magnitude range in the starlist is from magnitude 8 to 14; these are the 21,000 brightest stars. This process reduces the amount of data that I need to store by about 10 times: 6000 images take up 40Gb in APL format, but only about 4Gb if just the information around the target stars is retained. This is done image by image of course, but then the samples are re-filed star by star, and added to the previous data for each star. The net result is 21,000 files, one for each star (the 'starbook'), and each with n pixel samples, where n is the number of good images from the season. This makes a convenient database, which can be stored and accessed from one hard drive, whilst containing all the information needed for each star.
- f) In addition to the above, each image is probed at 2401 (49 by 49) fixed RA and Dec co-ordinates, and samples of 91 pixels square are taken. These are added and averaged in sets of 20 and 100 to provide a further database covering the whole image, rather than just the area around preselected stars. This is for the new object-finding program, see below. These form the working databases for subsequent analysis.

### **Picture Coefficients**

This is a vital link in the data reduction, so I provide a few more details here. There are obviously several ways of tracking a set of objects from images over a long period of time,

and one doesn't need to use sky co-ordinates to do so. However, although more complicated to set up, once it works, it enables one to have a fixed co-ordinate (J2000 equatorial RA and Dec) for each object, which can be related to external catalogues. Also it allows one to image any part of the sky, and then to get an automatic identification of all (well, most!) of the objects in the image. The method I use is to pattern match from the brightest 6000 stars in the image to a catalogue. That generally finds about 2,000 matches and a few wrong matches. The wrong ones can be removed by a first order fit. The rest are then sorted into 144 squares across the picture, and thinned to one per square. Generally some squares are empty at this stage, so the program goes through successive approximations using second, third and fourth order fits until it has a stable 4th order polynomial with a reference star in each square and a low rms error, of generally around 0.1 arcseconds. The reason for using this complex procedure is to take account of the moderately large field of view of the system (2.7 degrees square). There is appreciable curvature of RA and Dec over that area, and there are also significant optical system distortions (in terms of microns over the chip), so I found that a fourth order polynomial was necessary to get an rms error on the fit of the order of 0.1 arcseconds. The reason for insisting that it fits all 144 reference stars, is that a higher order curve can rapidly deviate if not constrained, particularly at the edges. Doing it this way, one can be certain that the picture will be probed with an x/y error much less than a pixel, so a mis-identification can't happen.

### New Object Finding

I've been conscious for the last 12 months, that the system of probing the images only at a preset list of co-ordinates would mean that if, say, a nova was to pop up in the field of view, there is a 90% chance that it would not be noticed! So I've now got a simple but effective system for avoiding that calamity, which uses the 100 and 20 average sets mentioned above. The reason for dividing each image up into lots of sub-squares is two-fold. There are minute angle changes of the order of 0.01 degrees during a night, and even bigger errors from night to night because I rotate the camera by 180 degrees at the E/W switchover, and the accuracy of repositioning is, at best, 0.1 degree. At the chip corners, 0.1 degree is 5 pixels, which would complicate the process of adding images and comparing the sums from night to night.

Using the sub-squares, with each one precisely centred at a particular RA and Dec, such errors are negligible. I had naively hoped that a simple correlation coefficient comparison of each of the 2401 averaged sample squares with ones from that night and previous ones would work, but of course it doesn't, because a faint new object in a square containing some bright stars just wouldn't be noticed. A much better method is to log an approximate brightness for all the objects in every square and look for changes. By averaging one hundred images, one can see much deeper of course, and the program, in fact, finds and tracks 250,000 objects in total, down to somewhere between magnitude 19 and 20. I run this program the day after every observing night, and it flags up, and presents a bitmap image, of anything which has brightened above mag 17, or has brightened by more than 2 magnitudes, or any new object. So far it has found between one and three new objects every time it has been run, but these have all so far been cosmic ray hits!

### The Kodak Blue-Plus Pixels

There is no doubt that I bought the wrong camera for this project! The two-part nature of the 'E' pixels led me into months of investigations to find the reason for the extra 'noise' and odd

dips and ripples that I found in the brightness curves. The pixels are effectively divided into two halves: the bottom half has a transparent gate, and a much higher quantum efficiency in all except the extreme red than the top half, which is polysilicon. The figures are shown in the table below. The wavelength is in nanometres (nm), QE<sub>tg</sub> and QE<sub>Poly</sub> are the quantum efficiencies of the transparent gate and the polysilicon halves of the pixel respectively.

<b>nm</b>	<b>QE<sub>tg</sub></b>	<b>QE<sub>Poly</sub></b>	<b>nm</b>	<b>QE<sub>tg</sub></b>	<b>QE<sub>Poly</sub></b>
400	60	2	640	99	33
420	57	7	660	105	31
440	60	10	680	97	33
460	66	14	700	82	34
480	75	15	720	69	35
500	68	20	740	58	34
520	72	24	760	52	36
540	66	34	780	46	36
560	67	37	800	27	37
580	84	32	820	22	38
600	88	32	840	25	35
620	87	35			

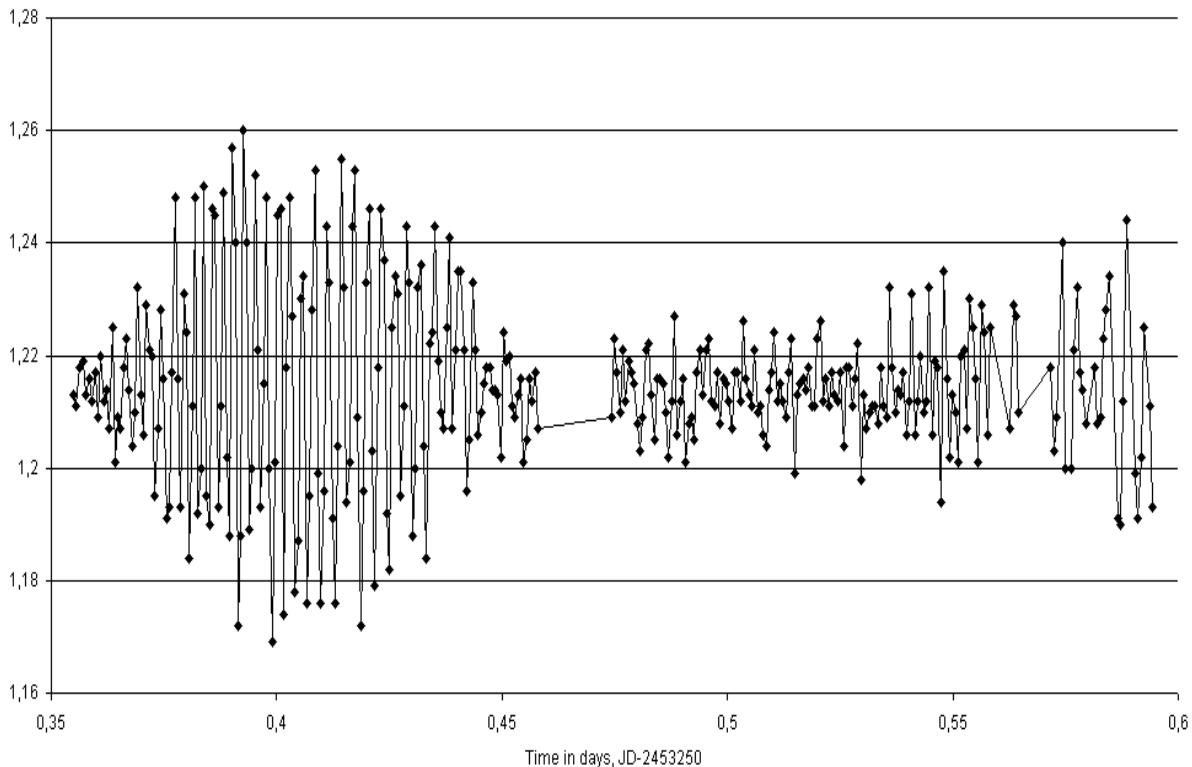
They are derived from the published quantum efficiencies of the blue-plus pixels (an average of the two halves) and of polysilicon. They are clearly not very accurate, but Kodak have seen and agreed with the numbers as the best available at the moment. If you are working in the blue with these pixels, you should be aware of the startling difference between the top and bottom half of the pixels. In effect, the image is being sampled over only half of the nominal area. This pixel design affects the output (as compared to the actual light input) star image in three ways:

- a) The brightness varies as the star centroid moves in y over the pixels.
- b) The apparent centroid is not quite the same in y as the light centroid.
- c) The apparent full-width half maximum (hereafter FWHM) is less in y than x for a circular input.

All three of these effects are interdependent. The variations that are caused are a very strong function of the image sharpness. With my set-up, the modulation becomes increasingly severe with apparent FWHMs below 1.6 pixels (3.8 arcsec), and it is inappreciable above 1.9. Figure 1 shows an example of this. This plot shows the ratio of two close stars that are about magnitude 9.8 (V). The high ripple occurred because it was a night of good seeing, and I carelessly allowed the focus to become too sharp. The x-axis is the image number, and the y-axis is a linear flux ratio.

These effects can be much reduced pre-facto by a tiny bit of defocussing, or (better) by using a phase plate to redistribute the light in the point spread function (hereafter PSF) into a more uniform patch without making it bigger. Post-facto it can be modelled out, but this is only

Fig 1, Pixel Effects, Ratio of stars 89/119 in date 2453250



easy with good quality circularly-symmetric PSFs. Alternatively, one can use a better positioned reference star. If the centroids of the two stars are separated in y by  $n+0.5$  pixels (as in the cases in the figure), the modulation is at its maximum, whereas at integral separations it almost disappears.

I now know that this is, in any case, not as serious a problem as I once thought, as the dip searching routines are not seriously disturbed by these modulations.

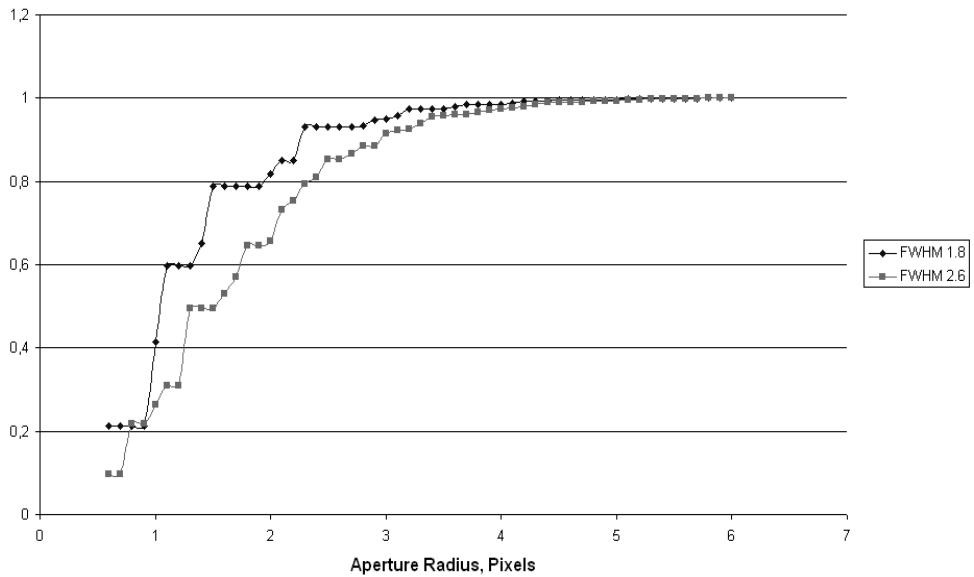
### Background Estimating

How to get the best possible estimate of the background level has been something I've spent a lot of time on over the years. I find that the errors that arise from this process are the most important source of deviations in the faintest stars. For a star totalling 300 analogue to digital units (hereafter ADU), the faintest on my starlist, a random error of just one ADU can affect the measurement by 6 or 7 %. If the effect were truly random, then it wouldn't matter, because it could be reduced to a very reasonable 1% just by averaging about 40 images (about 36 minutes for me), but it almost certainly isn't a random effect. The simplest method to deal with this, is to find the mode of the pixels around the star, and then take an average of those within a few ADU of the mode. However, in Cygnus, this does not work reliably enough, because of the high density of background stars. A better estimate can be found by averaging a few hundred image samples from a star, so that the true background pixels can be identified. This only needs to be done once, since the star centroid is always in the same position relative to those background pixels. They can then be used on each image to estimate the background.

That is still not ideal though, because with a limited number of pixels, the read-noise and the noise in the background itself imposes a variation on the estimate. One has to either sacrifice some spatial variability or some temporal variability, to reduce the noise by averaging. I do

it spatially, by grouping the stars in 100 subsquares across the image, and then taking an average of the lowest half of the values for the stars in that box, except for those stars very close to a bright one; they have to be treated individually. How well the background is known will determine the optimum strategy for forming brightness ratios. With good background knowledge, it is generally better to use a selection of brighter stars to form ratios (with the same size circles or with a correction for FWHM). If the background is at all uncertain, then it is better to ratio stars of the same brightness as long as the stars are close to each other and the same value of background is used for both.

Fig 2, Sample Growth Curves, Star 119



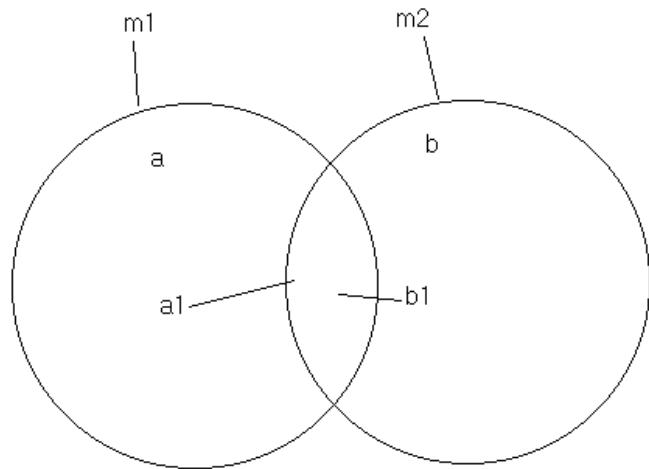
### Growth Curves and Flux ratios in Dense Starfields

I'm a great fan of growth curves! An example of a growth curve obtained from my system at moderate focus is shown in Figure 2 above. As you can see, it is very steppy at low radii because of pixel quantising and, sadly, because of the non-uniform pixels. One can only improve on this by star and pixel modelling, which rather defeats the purpose of using a simple concept. So, although, by doing a best fit curve, one can say that the 50% pickup is, say, at a diameter of 2.5 pixels, if you then try and measure a star at that diameter and double it to get the infinity value the value you get will be in error by as much as +/- 10%.

Those errors persist until you get to the 95% circle, by which time the error is only a few tenths of a percent. However, it certainly is useful to know what the 95 and 99% radii are, because in a crowded starfield one may get much more accurate results by multiplying the 95% value by 1.05, than using a contaminated circle at 99 or 99.9%. Because, for me, using the TMB the image quality varies significantly over the field, I resort once again to the squares, this time just 100 of them, each 408 pixels on a side. The most isolated star in each square is chosen, and a 50 circle growth curve calculated from 80% pickup to 99.99%+. Each of those is then used as a template for the rest of the stars in each box, and the program

uses 95 or 99% circles as appropriate to the environs of that particular star. It's very quick to do, and a star can be calculated for a whole season (10,000 ish samples) in a couple of seconds.

For closely spaced stars a simple correction can be made for the influence of one on the other. Consider Fig 3 (above), the two circles represent the 95 or 99% circles for the stars (both the same). One star has a total true flux of  $a$ , the other of  $b$ , and these are the numbers that we seek. The true amount of  $a$  in the overlap region is  $aI$ , similarly the overlap for  $b$  is



### **Figure 3, Closely-Spaced Stars need a Correction**

b1. We can measure the apparent flux (just the aperture output) for the two stars,  $m1$  and  $m2$  and also the combined total for both,  $T$ . Clearly we can write:

$T=a+b$	1
$m1=a+b1$	2
$m2=b+a1$	3
$a1/a=b1/b$	4

So with these four equations we can find the 4 unknowns:

$$a = T(T - m_2)/2T - (m_1 + m_2)$$

and the rest follow.

Here is an example: the measured values are  $T=2000$ ,  $m1=1500$  and  $m2=1000$ . So, substituting into the formula,  $a$  is 1333 and  $b$  is 667, which is a considerable difference from the measured values, and substantially more accurate. A further small correction can be made, particularly if 95% circles are being used. Essentially all of that missing 5% is in an annulus a couple of pixels wide outside the 95% circle, so some of it is being collected by the other star, and this is pretty closely equal to the angles subtended or  $(\arctan r/s)180$  where  $r$  is the measuring circle radius and  $s$  is the centroid separation. A typical value is about one fifth;

$5\%/5$  is 1% so 1% of  $b$  needs to be subtracted from  $a$  and vice versa, and both of these need to be multiplied by 1.05 to get infinity values.

Another simple correction can be used for faint stars close to much brighter ones. It is usually inaccurate to use 95 or 99% circles on very faint stars, and small circles are ill defined. I've found that, a better method is to use the ratio of the star and a close reference star, by using just the middle 9 pixels which generally covers about 70% of the total for me, with the centroid somewhere in the middle pixel; this produces a result which is less noisy and less prone to other errors compared to using circles.

If the faint star is close to a much brighter one, a not uncommon occurrence in Cygnus, a simple correction can be applied that greatly improves the estimate for the faint star. For me, a typical 99% radius is 4 pixels. As an example, consider the case of a faint star just 5 pixels away from a star that is 5 magnitudes brighter, so that it is just outside the 99% circle. The 9 pixels will then intercept (closely enough) one tenth of that 1% (or 10% of the faint star). This represents a substantial error and a large (but not uncommon) change in the PSF such that the 98% circle grows to where the 99% one was would double that. So simply taking off these extra amounts contributed by the bright star, can greatly reduce the variability of the faint star. By using tricks such as these I find it becomes possible to detect a 2% dip in even the faintest stars in the list.

### **Results so far: Noise and Precision**

Averaging over a time interval of 30 minutes (33 images), the rms noise levels on a good night can vary from around 0.1% ( $S/N=1000$ ) for stars of magnitude 8 to 9 up to 0.5% ( $S/N=200$ ) for the faintest stars that I can sensibly measure at magnitude 13 to 14. This implies a resolution, at best, of about 1 millimagnitude for objects varying on timescales of not less than an hour. Fig 4 is a plot of a fast, low amplitude and irregular pulsator to illustrate the point. This is plotted for a running average of 30 data points, but is otherwise almost raw data. The resolution is, of course, very different from my day to day accuracy, and I don't yet know what that is. This stability is of great importance for variable star work, but of almost no consequence as far as transit searching is concerned.

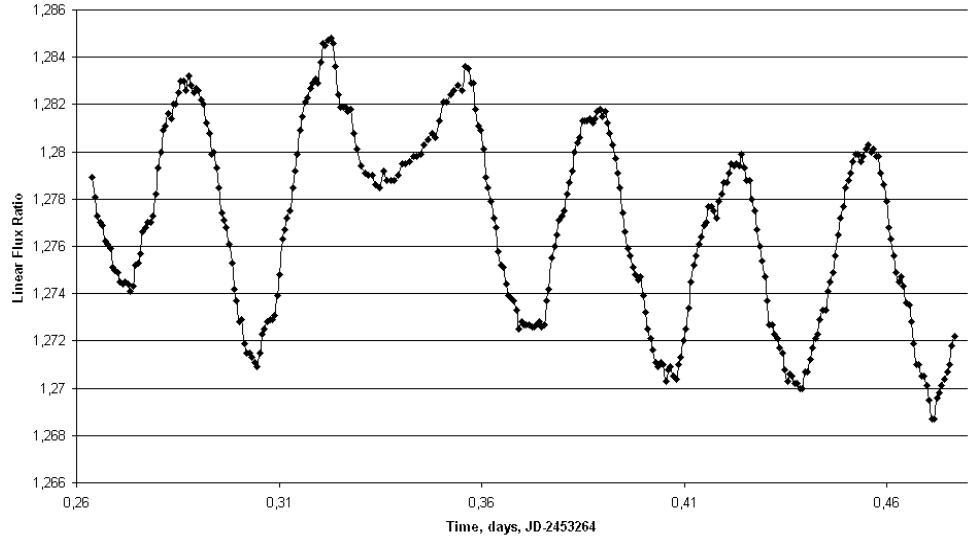
### **Results so far: Variable Stars**

I haven't yet produced an exhaustive listing of all the variable stars in 'my' small area of Cygnus, but of the 17,000 stars being monitored, more than a thousand vary in some way, and I suspect that number will grow to over 2,000. Most of the remaining ones will be uncovered during the transit searching, because the data has to be carefully cleaned and levelled for that. The stars that I have looked at, cover the expected range from long period, high amplitude red stars to low amplitude pulsators, down to periods of 50 minutes. I'm hoping to produce a paper summarising the statistics in 6 to 12 months time.

### **Results so far: Transit Searching**

As I write this (November 3rd), I'm within about a month of being able to search the data bases for transit dips. The method has been tested, and the final figures show some simulation results. The detection method is very simple, and is just a matter of doing a running correlation coefficient between the data, and a rectangular dip of the required length. I have

Fig 4, 30pt raw of 169 vs refstar 240 in date shown



found the results to be more generally robust, if the correlator is followed by an integrator. In principle it is all very simple: if the output from the integrator routine exceeds a threshold, a dip has been found, so setting the threshold to minimise false alarms and maximise the chances of a detection is the key to the process. On good data it works very well. In Fig 5a a 3 hour 0.2% dip has been inserted into the brightness ratio data for a magnitude 9.8 (V) star. The integrator output for that input is shown in Fig 5b. The top curve is the output with the dip and the bottom curve the output without the dip. Clearly, if the threshold were set to any positive value, a very clear detection would be achieved in this particular case, although the dip cannot be seen by eye in the data (though it can be with a 100pt running average). A more challenging case is shown in Figs 6a and 6b. These are for one of the faintest stars in the field and are therefore much noisier; this time a 2% dip has been inserted. It so happens that the data had a small positive movement in it, which is why the curve with no dip goes negative. It could equally well have gone positive though, so a threshold of at least 2.5 should be used. Even so, the detection is quite definite.

These results are extremely encouraging, in that they suggest that a 2% dip should be detectable on a good proportion of the 17,000 stars being monitored. However, it is by no means that simple in reality, because a lot of the data is not as good as the examples I've shown and the system still needs a lot of work to bring it to a state where the false alarm rate is acceptable. Even then, there will be a lot of false alarms from data artifacts to be examined. Additionally, I expect that there will be astrophysical false alarms that I will need outside help with. I am told that these are likely to include, among other things, eclipsing binaries with a bright companion which dilutes the dip and brings it down to the 1-2% level; eclipsing binaries with a line-of-sight companion; and eclipsing systems where one star is much brighter than the other, producing a dip that is almost indistinguishable from a planet transit.

From the statistics behind the TrES-1 discovery, I know realistically that my chances of getting a confirmed transit out of the 2003/4 plus the 2004/5 data is only about 20%, but it's going to be a lot of fun looking!

Fig5a, 0.2% 3 hour inserted dip in 89/119

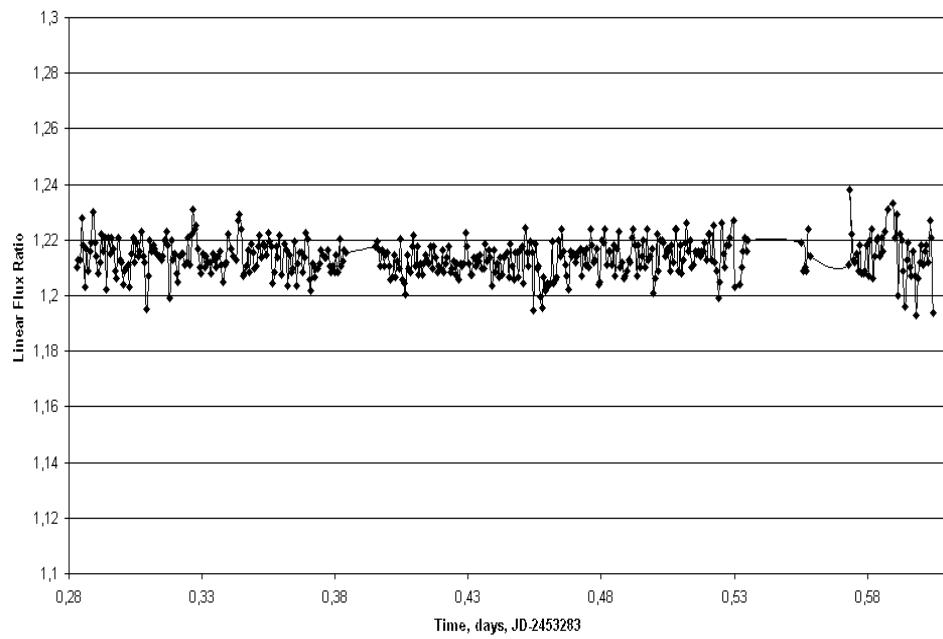


Fig5b, Integrated Correlation Coefficient with and without 0.2%dip

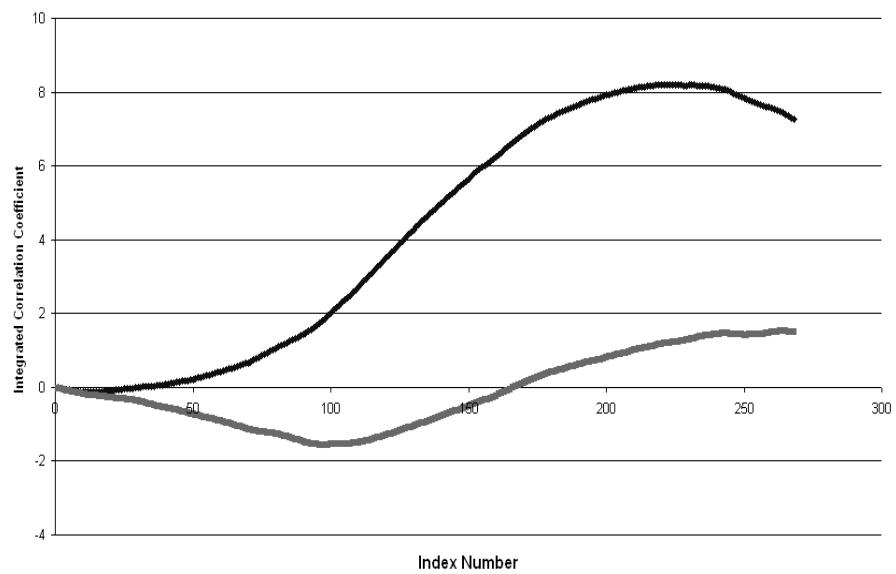


Fig 6a, 2% dip inserted in star 21,000/ ref 1015

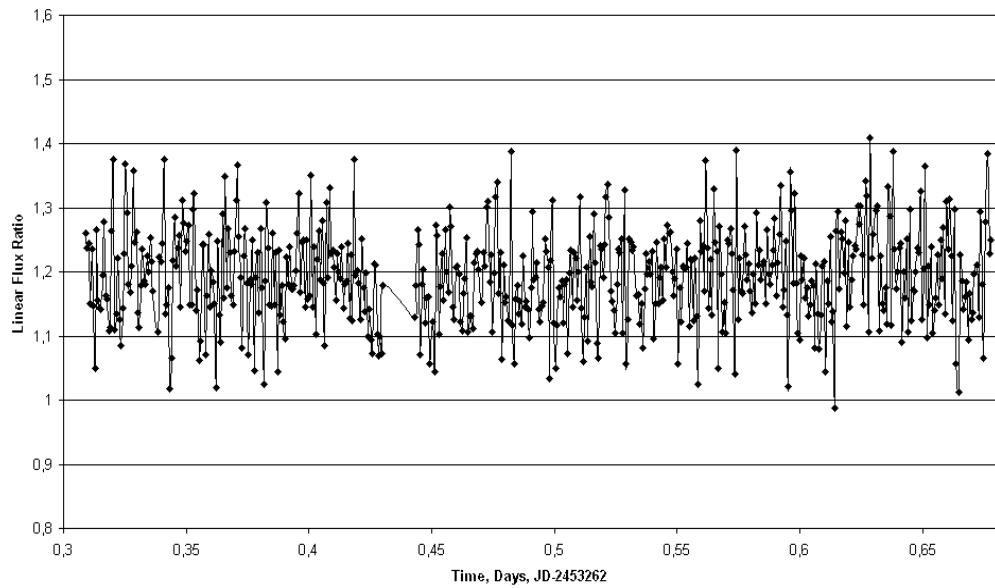
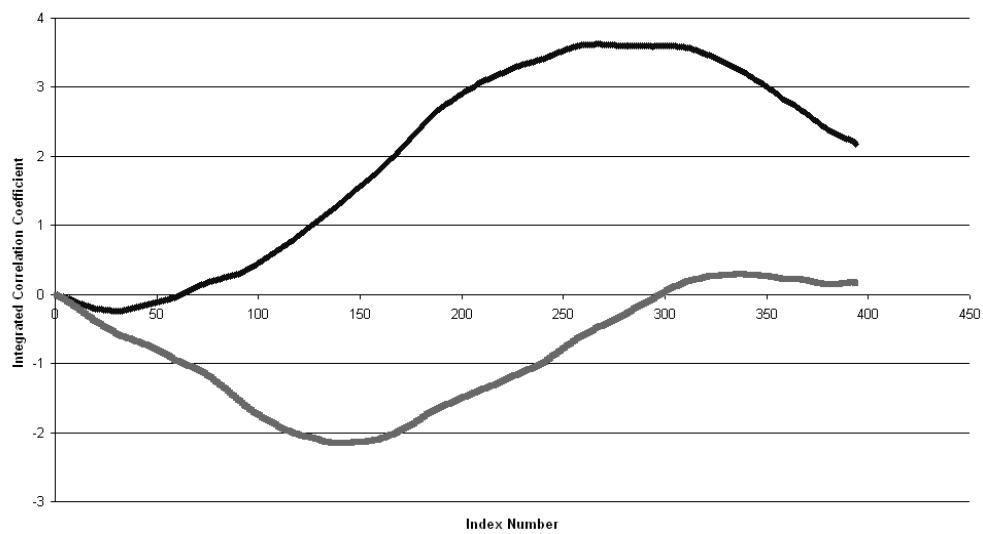


Fig 6b, Integrated Correlation Coefficients with and without 2% dip



#### Acknowledgements

I'd like to thank, in particular Bob Forrest from the University of Herts, Roger Pickard and Norman Walker from the UK, and Tim Brown from the US, for the helpful suggestions and comments they have made over the years, and also Cathy Hall for spending time on the variable star data.

## **A SUMMARY OF THE MINUTES OF THE VSS OFFICERS MEETING, HELD ON MARCH 6TH 2004, AT SHOBDON**

**MELVYN TAYLOR**

Present: Roger Pickard, John Saxton, John Toone, Tony Markham, Gary Poyner, Richard Miles, Karen Holland

Apologies were received from Guy Hurst

### **The Database (Visual only)**

John Saxton described how he was working to ensure that the database could be automatically-generated in the future; he was facilitating this by providing observers with appropriate software. If observers ran their observations through this software, it generated a checked file that was in the correct format for being accepted into the database. John usually ran this software himself, but the beauty of asking the original observer to run the software, was that they could then correct the mistakes that the software would detect, which resulted in a far greater degree of automation in the creation of the database.

There were a few minor “bugs” in the software, as with any new software, that John was ironing out. Once this had been completed, then John intended to proceed with an explanatory article (see VS 119 p5).

### **Paper records**

Roger commented that he was intending to collect all the outstanding paper records that still needed to be PC-entered from Crayford, for storing at Shobdon. There were possibly 4 filing cabinets of records left; he estimated that around 90% of all records were now in electronic format. Currently, entering the data into PC format was being done by 6 people. Melvyn commented that 13 to 15 members were still reporting on paper.

It was noted that S Dunlop might have some years of data for AG Peg and CH Cyg, and Melvyn agreed to check on this. John Toone also thought that there might be some old SS Cyg observations held by some members. Roger had been handed some observations by J.Friends at the last BAA exhibition meeting, but had yet to check if they were already in the database.

### **The Telescopic and Binocular Programmes**

It was agreed that the status of telescopic stars that had no estimates in the database should be reviewed, and John Saxton agreed to check the database to identify which these were.

Melvyn was sure that several Miras and long period variables were under-observed. Binocular variables had been categorised into three groups, and the priority list which appears in each edition of the VSSC should be reviewed.

Norman Walker had offered to have a quick look to see if any possible periods could be identified in the LB class of binocular variables, by performing a fourier analysis on the data.

The 2003 telescopic and binocular stars, for which observations had been reported on paper, still needed totalling for the Director's report.

### **The Recurrent Objects Programme**

Charts for this programme were being improved through the help of Henden and Simonsen. About 10 stars per year were added to the ROP. There were a few CCD observers of ROP stars, but most of the observers were visual observers, numbering around 4 at the start of the project (ROP) in 1990, and numbering up to 20 to 30 at best.

Outbursts (numbering around 10 to 15 per year) were mainly reported by visual methods, with all UK estimates going to the database. There was a general rule that if a ROP object did not have an observed outburst within 1 year of starting to be observed, then it was taken off the list. Gary noted that the All Sky Survey was also monitoring recurrent novae, and other types of objects that were included on the ROP.

### **The Eclipsing Binary Programme**

Tony reported that he was planning on reducing the eclipsing binary programme from 140 stars to 95. The proposed transitional list appeared in VSSC 119 starting on page 11. The eventual aim, was to try to reduce this further to around 70-80 stars.

The predicted times of minimum of programme objects continued to appear in the VSSC. The number of active observers was from around 8 to 10, and Tony was keen to encourage new observers; his Winchester workshop article was to be in the August JBAA, which would be appearing at about the right time for potential new observers to take on long runs of estimates over the winter. The forthcoming Eta Gem eclipse minimum was discussed, with a subsequent article in VS120 page 17.

### **The “New” VS Programme**

This programme consisted of 20 of Mike Collin's discoveries, and were mainly being followed by Hazel McGee, Chris Jones, Graham Salmon and Richard Hunt.

### **Charts and sequences**

The International Chart working group, of which John had been a member, appeared to have “fizzled-out”. John mentioned that assistance from Henden and Simonsen had been very useful in the amendment of comparison star sequences, especially for some ROP objects. John had been offered some assistance with drawing charts, and had been working with up to three assistants on charts.

A request was made for all good charts to be put on the web pages for ease of access. David Griffin had scanned many charts, and so this should be possible. The chart catalogue now had all telescopic and binocular variables in constellation order.

### **The Faulkes Telescope**

Roger wondered if it might be possible to use the Faulkes Telescope to check comparison

star sequences. It was agreed that a list should be drawn up to include all stars for which sequences needed measuring. This should include RA and Dec for each star, treating ROP stars as priority, then miras and long period variables, followed by semi-regulars. Richard suggested that the TASS sky survey could also be used for sequence-checking, and that it was accessible via the Web. This had the advantage of providing V-I colour magnitudes, and might therefore help in the selection of comparison stars of a similar colour to the variable, as well as checking for the possibility of intrinsic variability of comparison stars.

### **Circulars**

Karen reported that over the 8 years that she had been producing the circular, the number of subscribers had increased from less than 150 to 170. The next issue was to be a *bumper* size issue again. Karen commented that there was a general shortage of articles, and requested readable, *news* articles, *observer profiles* along with any other contributions. Six subscribers had converted to PDF subscriptions, and this appeared to be an attractive way of accessing the circulars, leaving a few more paper copies spare for selling at meetings, or offering to potential new members. Several CDs of VSSCs in PDF format had been sold.

### **Pro-Am Liason Committee**

Roger told the group that whilst this group had served a useful purpose during its existence, it had now wound-up.

### **CCD Photometry and the CCD Database**

The CCD target list was now on the web site, and for ease of display at meetings the list had been reproduced as a poster. The list contains four different categories of project: 1) basic photometry, 2) time-series photometry, 3) approximate differential photometry, 4) precision photometry. Some objects have CCD charts to ease measurement of the objects, but it was noted that more were required. It was agreed that, except where there was a danger of mis-identification of a star, the CCD sequence would not need to be reproduced in chart form, but could take the form of a list including the relevant information.

Richard said that he was working to finalise a simplified form of the PEP template in readiness for the May CCD Workshop. The CCD committee currently consisted of David Boyd, Richard Miles, Roger Pickard, Karen Holland and Andy Wilson.

### **CCD Photometry Workshop**

Karen reported that the arrangements for this two-day meeting, to be held in Northampton, were well in hand. Karen was looking for suitable overnight accommodation, and noted that the meeting might be a good time to launch a CCD mentoring scheme.

The workshop programme currently had David Boyd, John Saxton, Roger Pickard, Richard Miles, Karen Holland and Nick James contributing. Richard said that he would email details of the Symposium to known international groups e.g. the Yahoo e-Group on CCD-Astrometry-Photometry. Melvyn suggested that members of the IOTA ESOP group might also be interested.

### **Section meeting at Alston Hall**

Another two day VSS meeting was planned at Alston Hall for 2004, over the weekend of October 22 to 24. It had been decided that the meeting would start on the Friday afternoon, and would finish at lunchtime on the Sunday in the hope that travel would be easier with this arrangement.

Professor Don Kurtz was already booked, and it was hoped that Mike Simonsen, Bruce Sumner and Professor Tom Harquist (Leeds University) might also attend.

### **Observing Guide**

Roger reported that this was an A5 sized 64 page booklet, containing general information regarding observing, and including some charts for various telescopic, binocular and eclipsing binary stars. This was to include some charts on an accompanying CD, but plans for this had now been abandoned. Don Miles had been contacted with the material and art work for the production of this guide, but progress to date had been slow.

### **Web Site**

Roger reported that the VSS Web site now contained notice of the May CCD Symposium. The chart cataloguing had not been a success. Since Peter Moreton's resignation, it was necessary to find a new webmaster, and David Grover, David Griffin and John Fairweather were all possible replacements.

### **UK alert group**

This had been started on January 17th, 2004, and there were now a total of 33 members/subscribers; 64 messages had been transferred at the date of this meeting. Gary noted that there were several overseas subscribers, including VSNET members.

### **Mentoring Scheme**

Karen noted that after a relatively slow start there were now 5 visual mentees, 3 CCD mentees and 19 mentors. Karen was hoping to launch the CCD mentoring scheme at the May 16/17 event.

### **Posters**

Karen asked if anyone had any ideas for possible themes for posters in size A3 to A1. A2 sizes were best suited to our display boards, but small-sized A4 to A3 posters were the optimum size for being laminated.

### **AOB**

Karen wondered if the increasing number of CCD photometry specific articles that were being contributed for the VSSC, should be presented in a separate occasional CCD specific publication, but it was agreed that they should continue to be published in the existing VSSC.

Melvyn presented a rough version of the Binocular VS Chart booklet. Vol.2. This was a booklet of A5 size with 31 variables and 28 charts. A front cover design/motif was agreed, and it was suggested that if camera-ready copy were produced, then Karen could get 200 produced through the circular printer.

John Toone wondered if we should produce similar publications for telescopic variable stars, eclipsing binary stars, and the recurrent objects programme.

It was agreed that the Variable Star of the Year for 2006, suggested by Tony, should be the Algol-type eclipsing binary U Cep (high declination).

It was reported that 10 CCD colour filter wheels were being purchased by the BAA for loan.

## BINOCULAR PRIORITY LIST

MELVYN TAYLOR

Variable	Range	Type	Period	Chart	Variable	Range	Type	Period	Chart
<i>AQ And</i>	8.0-8.9	SRC	346d	82/08/16	<i>AH Dra</i>	7.1-7.9	SRB	158d?	106.01
<i>EG And</i>	7.1-7.8	ZA	072.01		<i>NQ Gem</i>	7.4-8.0	SR+ZA	70d?	077.01
<i>VAql</i>	6.6-8.4	SRB	353d	026.03	<i>X Her</i>	6.3-7.4	SRB	95d?	223.01
<i>UU Aur</i>	5.1-6.8	SRB	234d	230.01.	<i>SX Her</i>	8.0-9.2	SRD	103d	113.01
<i>AB Aur</i>	7.2-8.4	INA		83/10/01	<i>UW Her</i>	7.8-8.7	SRB	104d	107.01
<i>V Boo</i>	7-12	SRA	258d	037.01	<i>AC Her</i>	6.8-9.0	RVA	75d	048.03
<i>RW Boo</i>	6.4-7.9	SRB	209d	104.01	<i>IQ Her</i>	7.0-7.5	SRB	75d	048.03
<i>RX Boo</i>	6.9-9.1	SRB	160d	219.01	<i>OP Her</i>	5.9-6.7	SRB	120d	84/04/12
<i>ST Cam</i>	6.0-8.0	SRB	300d?	111.01	<i>R Hya</i>	3.5-10.9	M	389d	049.01
<i>XX Cam</i>	7.3-9.7?	RCB?		068.01	<i>RX Lep</i>	5.0-7.4	SRB	60d?	110.01
<i>X Cnc</i>	5.6-7.5	SRB	195d	231.01	<i>SS Lep</i>	4.8-5.1	ZA		075.01
<i>RS Cnc</i>	5.1-7.0	SRC	120d?	84/04/12	<i>Y Lyn</i>	6.9-8.0	SRC	110d	229.01
<i>VC Vn</i>	6.5-8.6	SRA	192d	214.01	<i>SV Lyn</i>	6.6-7.5	SRB	70d?	108.01
<i>WZ Cas</i>	6.9-8.5	SRB	186d	82/08/16	<i>U Mon</i>	5.9-7.8	RVB	91d	029.03
<i>V465 Cas</i>	6.2-7.2	SRB	60d	233.01	<i>X Oph</i>	5.9-9.2	M	328d	099.01
<i>γ Cas</i>	1.6-3.0	GC		064.01	<i>BQ Ori</i>	6.9-8.9	SR	110d	84/04/12
<i>rho Cas</i>	4.1-6.2	SRD	320d	064.01	<i>AG Peg</i>	6.0-9.4	NC		094.01.
<i>W Cep</i>	7.0-9.2	SRC		83/10/01	<i>X Per</i>	6.0-7.0	GC+XP		84/04/08
<i>AR Cep</i>	7.0-7.9	SRB		85/05/06	<i>R Sct</i>	4.2-8.6	RVA	146d	026.03
<i>mu Cep</i>	3.4-5.1	SRC	730d	112.01	<i>Y Tau</i>	6.5-9.2	SRB	242d	84/04/12
<i>O Cet</i>	2.0-10.1	M	332d	039.02	<i>W Tri</i>	7.5-8.8	SRC	108d	114.01
<i>R CrB</i>	5.7-14.8	RCB		041.02	<i>Z UMa</i>	6.2-9.4	SRB	196d	217.01
<i>W Cyg</i>	5.0-7.6	SRB	131d	062.1	<i>ST UMa</i>	6.0-7.6	SRB	110d?	102.01
<i>AF Cyg</i>	6.4-8.4	SRB	92d	232.01	<i>VY UMa</i>	5.9-7.0	LB		226.01
<i>CH Cyg</i>	5.6-10.0	ZA+SR		089.02	<i>V UMi</i>	7.2-9.1	SRB	72d	101.01
<i>U Del</i>	5.6-7.5	SRB	110d?	228.01	<i>SS Vir</i>	6.9-9.6	SRA	364d	097.01
<i>EU Del</i>	5.8-6.9	SRB	60d?	228.01	<i>SW Vir</i>	6.4-7.9	SRB	150d?	098.01
<i>TX Dra</i>	6.8-8.3	SRB	78d?	106.01					

## THE VS CCD MENTORING SCHEME

KAREN HOLLAND

The Variable Star Mentoring Scheme was set up a couple of years ago specifically to assist new visual observers, or observers who were new to the field of Variable Star Observing. Following the success of this scheme, and after a number of requests, a CCD Mentoring scheme has now been set up. The aim is to provide newcomers to CCD photometry, a mentor to whom they can turn for guidance or advice, whilst they learn the techniques essential to good photometry. As much, or as little, assistance as is required can be offered. As with the Visual mentoring scheme, it is thought that some CCD observers will require a mentor for a short time, to provide confirmation of their already good methods, whilst others may require guidance for a longer period. If you feel a CCD mentor would be useful to you, please contact Karen Holland (details on the back cover) to be allocated a mentor.

## ECLIPSING BINARY 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/end 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 Jan 8, TW Dra D17(19)24 indicates that TW Dra will be in mid eclipse at approx 19h UT. The eclipse will be observable between approx 17h UT and midnight UT, 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 :

<b>RS CVn</b>	7.9-9.1V	<b>Z Dra</b>	10.8-14.1p	<b>U Sge</b>	6.45-9.28V
<b>TV Cas</b>	7.2-8.2V	<b>TW Dra</b>	8.0-10.5v	<b>RW Tau</b>	7.98-11.59V
<b>U Cep</b>	6.75-9.24V	<b>S Equ</b>	8.0-10.08V	<b>HU Tau</b>	5.92-6.70V
<b>SS Cet</b>	9.4-13.0v	<b>delta Lib</b>	4.9-5.9V	<b>X Tri</b>	8.88-11.27V
<b>U CrB</b>	7.7-8.8V	<b>Z Per</b>	9.7-12.4p	<b>TX UMa</b>	7.06-8.80V
<b>SW Cyg</b>	9.24-11.83	<b>VY Psc</b>	9.44-12.23V	<b>Z Vul</b>	7.25-8.90V

Note that predictions for **RZ Cas**, **Beta Per** and **Lambda Tau** can be found in the BAA Handbook.

Several long period eclipsing variables have eclipses due during this interval. These include **BL Tel** (mid eclipse Jan 08), **BM Cas** (Jan 20), **mu Sgr** (Feb 10) and **W Cru** (Mar 09). For further details, see VSSC 114.

<b>2005 Jan 1 Sat</b>	Z Vul	18(24)19L	Z Per	17(22)27	S Equ	D17(13)18L	
TV Cas	03(07)07D	RS CVn	L21(23)29	TX UMa	19(23)28	HU Tau	D17(15)18
U Cep	D17(15)20	RW Tau	22(26)28L	<b>2005 Jan 15 Sat</b>	Z Vul	D17(17)18L	
X Tri	D17(17)19	<b>2005 Jan 8 Sat</b>	Z Vul	L04(08)07D	TW Dra	D17(19)24	
S Equ	D17(22)19L	HU Tau	01(05)04L	S Equ	D17(16)18L	TV Cas	21(25)29
Z Dra	18(20)23	Z Vul	L05(00)05	TV Cas	D17(19)23	X Tri	23(26)25L
HU Tau	21(25)28L	Z Dra	D17(15)18	SS Cet	23(27)24L	<b>2005 Jan 23 Sun</b>	
<b>2005 Jan 2 Sun</b>	TW Dra	D17(19)24	U CrB	L24(18)24	U Sge	D17(19)18L	
U CrB	L00(<<)05	S Equ	D17(19)19L	<b>2005 Jan 16 Sun</b>	U Cep	20(25)30	
RW Tau	D17(13)18	Z Per	D17(20)24	U Cep	D17(14)19	Z Per	21(26)28L
X Tri	D17(16)19	TX UMa	D17(20)25	Z Dra	D17(19)21	X Tri	23(25)25L
Z Per	D17(17)22	U Cep	21(26)31D	SW Cyg	D17(19)23L	TX UMa	23(28)31D
TX UMa	L17(17)22	<b>2005 Jan 9 Sun</b>	TW Dra	24(29)31D	<b>2005 Jan 24 Mon</b>		
SW Cyg	20(26)24L	U CrB	L00(<<)02	<b>2005 Jan 17 Mon</b>	HU Tau	D17(16)20	
RS CVn	L22(28)31D	Z Dra	21(24)26	SW Cyg	L01(<<)01	RW Tau	D17(17)22
TV Cas	22(26)30	SS Cet	24(29)24L	U Sge	L05(01)07	TV Cas	D17(20)24
TW Dra	23(28)31D	<b>2005 Jan 10 Mon</b>	TV Cas	D17(14)18	Z Dra	20(22)25	
<b>2005 Jan 3 Mon</b>	HU Tau	03(07)04L	Z Vul	D17(19)19L	SS Cet	21(25)23L	
SW Cyg	L02(02)07D	TV Cas	04(08)07D	Z Per	19(24)28L	X Tri	22(25)25L
Z Dra	03(05)07D	U Sge	L05(07)07D	TX UMa	20(25)29	<b>2005 Jan 25 Tue</b>	
Z Vul	L05(02)07D	Z Vul	05(11)07D	<b>2005 Jan 18 Tue</b>	Z Vul	L04(04)07D	
U Sge	07(12)07D	RW Tau	D17(21)26	Z Dra	01(03)06	TW Dra	D18(15)20
U Sge	D17(12)18	Y Psc	17(22)22L	U Cep	21(26)30	SW Cyg	D18(23)23L
X Tri	D17(16)18	<b>2005 Jan 11 Tue</b>	SS Cet	22(27)24L	Y Psc	19(23)21L	
U Cep	22(27)31D	Z Dra	06(08)07D	U CrB	23(29)31D	X Tri	21(24)25L
HU Tau	23(26)28L	TW Dra	D17(14)19	RW Tau	23(28)28L	U CrB	L23(27)31D
<b>2005 Jan 4 Tue</b>	U Cep	D17(14)19	<b>2005 Jan 19 Wed</b>	<b>2005 Jan 26 Wed</b>			
X Tri	D17(15)17	Z Per	D17(21)26	del Lib	L03(03)07D	SW Cyg	L01(<<)05
TV Cas	18(22)26	TX UMa	D17(22)26	TV Cas	06(10)07D	del Lib	L02(02)07D
<b>2005 Jan 5 Wed</b>	TV Cas	24(28)31D	TW Dra	19(24)29	Z Dra	04(07)07D	
RW Tau	03(08)04L	<b>2005 Jan 12 Wed</b>	<b>2005 Jan 20 Thu</b>	U Cep	D18(13)18		
del Lib	L04(04)07D	SW Cyg	L01(06)07D	Z Vul	L04(06)07D	TV Cas	D18(16)20
U CrB	04(10)07D	U CrB	02(08)07D	U Sge	L05(10)07D	HU Tau	D18(17)21
Z Vul	D17(13)18	del Lib	L03(03)07D	Z Dra	18(20)23	X Tri	21(23)25L
Z Per	D17(18)23	Z Dra	D17(17)19	Z Per	20(25)28L	RS CVn	21(28)31D
TX UMa	D17(19)23	Z Vul	D17(21)19L	TX UMa	22(26)31D	Z Per	23(28)28L
TW Dra	18(23)28	RS CVn	L21(18)25	<b>2005 Jan 21 Fri</b>	<b>2005 Jan 27 Thu</b>		
Z Dra	20(22)25	SS Cet	23(28)24L	X Tri	01(03)01L	TX UMa	01(05)07D
HU Tau	24(28)28L	<b>2005 Jan 13 Thu</b>	TV Cas	01(05)07D	U Sge	L04(04)07D	
<b>2005 Jan 6 Thu</b>	RW Tau	D17(15)20	SW Cyg	03(09)07D	Z Vul	D18(15)18L	
U Cep	D17(14)19	U Sge	D17(16)18L	del Lib	04(11)07D	Z Dra	D18(15)18
TV Cas	D17(17)21	TV Cas	19(23)27	U Cep	D17(13)18	X Tri	20(23)25L
U Sge	D17(22)19L	U Cep	21(26)31	RW Tau	18(23)27L	SS Cet	20(25)23L
<b>2005 Jan 7 Fri</b>	Z Dra	23(26)28	SS Cet	21(26)24L	<b>2005 Jan 28 Fri</b>		
SS Cet	01(05)01L	<b>2005 Jan 14 Fri</b>	<b>2005 Jan 22 Sat</b>	del Lib	04(10)07D		
Z Dra	04(07)07D	TW Dra	04(09)07D	X Tri	00(03)01L	TW Dra	05(10)07D
del Lib	05(12)07D	del Lib	05(11)07D	RS CVn	02(09)07D	HU Tau	D18(19)23
SW Cyg	D17(16)22	Y Psc	D17(16)21	Z Dra	03(05)07D	X Tri	19(22)24

U Cep	20(25)30	Z Dra	D18(19)21	SW Cyg	24(30)30D	<b>2005 Feb 22 Tue</b>	
Z Dra	22(24)26	RW Tau	D18(19)24	<b>2005 Feb 13 Sun</b>	SW Cyg	03(09)06D	
<b>2005 Jan 29 Sat</b>		<b>2005 Feb 5 Sat</b>	U Sge	L03(02)06D	S Equ	06(11)06D	
Y Psc	D18(18)20L	Z Per	03(08)03L	TV Cas	D18(19)23	TW Dra	D18(16)21
X Tri	19(21)24	TX UMa	05(10)06D	Y Psc	D18(19)19L	TV Cas	D18(20)24
<b>2005 Jan 30 Sun</b>		U CrB	06(11)06D	<b>2005 Feb 14 Mon</b>	U Cep	19(23)28	
Z Per	00(05)04L	X Tri	D18(16)19	TW Dra	01(06)06D	U CrB	L21(18)24
RW Tau	01(06)03L	TW Dra	D18(20)25	HU Tau	02(05)02L	<b>2005 Feb 23 Wed</b>	
TX UMa	02(07)07D	S Cet	18(23)23L	Z Dra	05(07)06D	del Lib	L01(01)06D
TV Cas	03(07)07D	RS CVn	L19(18)24	TX UMa	D18(14)19	U Sge	L02(05)06D
Z Vul	L03(02)07D	HU Tau	20(24)26L	SS Cet	D18(21)22L	Z Per	D18(16)21
Z Dra	06(09)07D	<b>2005 Feb 6 Sun</b>	<b>2005 Feb 15 Tue</b>	Z Dra	D18(19)21		
SW Cyg	D18(13)19	Z Dra	01(03)06	RS CVn	02(08)06D	TX UMa	D18(19)24
HU Tau	D18(20)24	U Sge	L03(08)06D	TV Cas	D18(14)18	SS Cet	D18(19)21L
X Tri	18(20)23	Z Vul	05(11)06D	RW Tau	D18(21)25	RW Tau	23(28)25L
SS Cet	20(24)23L	X Tri	D18(16)18	U CrB	L22(20)26	<b>2005 Feb 24 Thu</b>	
<b>2005 Jan 31 Mon</b>		<b>2005 Feb 7 Mon</b>	<b>2005 Feb 16 Wed</b>	TV Cas	D18(16)20		
TW Dra	00(05)07D	RW Tau	D18(13)18	del Lib	L01(01)06D	RS CVn	D18(23)29
Z Dra	D18(17)20	U Cep	19(24)29	Z Vul	L02(06)06D	<b>2005 Feb 25 Fri</b>	
X Tri	D18(20)22	HU Tau	22(25)26L	U Sge	05(11)06D	Z Dra	01(04)06D
RS CVn	L20(23)29	<b>2005 Feb 8 Tue</b>	TW Dra	21(26)30D	del Lib	02(09)06D	
TV Cas	22(26)30	TV Cas	04(08)06D	Z Dra	22(24)26	U CrB	23(29)30D
<b>2005 Feb 1 Tue</b>		TW Dra	D18(16)21	<b>2005 Feb 17 Thu</b>	<b>2005 Feb 26 Sat</b>		
X Tri	D18(19)22	SW Cyg	D18(16)22L	TV Cas	06(10)06D	Z Vul	L02(02)06D
HU Tau	D18(21)25	SS Cet	D18(22)22L	Y Psc	D18(14)18	Z Per	D18(17)22
RW Tau	20(24)27L	Z Dra	18(21)23	TX UMa	D18(16)21	SS Cet	D18(19)21L
U CrB	L22(25)30	U CrB	L22(22)28	SW Cyg	D18(20)21L	TX UMa	D18(20)25
Z Dra	23(26)28	<b>2005 Feb 9 Wed</b>	SS Cet	D18(20)22L	RW Tau	D18(22)25L	
<b>2005 Feb 2 Wed</b>		del Lib	L02(02)06D	U Cep	19(24)28	SW Cyg	D18(23)21L
Z Per	02(06)03L	Z Vul	L03(<<)03	SW Cyg	L23(20)26	SW Cyg	L22(23)29
del Lib	L02(02)06D	HU Tau	23(27)26L	<b>2005 Feb 18 Fri</b>	<b>2005 Feb 27 Sun</b>		
TX UMa	04(08)06D	TV Cas	24(28)30D	del Lib	03(09)06D	Z Dra	D18(21)23
X Tri	D18(18)21	<b>2005 Feb 10 Thu</b>	RW Tau	D18(15)20	U Cep	D18(23)28	
TV Cas	18(22)26	Z Dra	03(05)06D	<b>2005 Feb 19 Sat</b>	X Tri	22(25)23L	
SS Cet	19(24)23L	RS CVn	L19(13)19	U CrB	01(07)06D	<b>2005 Feb 28 Mon</b>	
TW Dra	20(25)30	<b>2005 Feb 11 Fri</b>	TV Cas	01(05)06D	TW Dra	02(07)06D	
U Cep	20(25)29	del Lib	03(09)06D	S Equ	L06(01)06D	TV Cas	03(07)06D
<b>2005 Feb 3 Thu</b>		Z Vul	03(08)06D	Z Dra	D18(17)20	HU Tau	D18(15)19
U Sge	L04(<<)04	TW Dra	06(11)06D	TW Dra	D18(21)26	X Tri	22(24)23L
X Tri	D18(18)20	SS Cet	D18(22)22L	RS CVn	21(27)30D	<b>2005 Mar 1 Tue</b>	
HU Tau	19(23)26L	TV Cas	19(23)27	<b>2005 Feb 20 Sun</b>	Z Dra	03(05)06D	
SW Cyg	20(26)22L	<b>2005 Feb 12 Sat</b>	Z Per	D18(14)19	S Equ	L05(08)06D	
SW Cyg	L24(26)30D	HU Tau	00(04)02L	TX UMa	D18(17)22	RW Tau	D19(17)22
<b>2005 Feb 4 Fri</b>		U CrB	03(09)06D	SS Cet	D18(20)22L	RS CVn	D19(18)24
Z Vul	L03(00)05	S Equ	L06(04)06D	TV Cas	21(25)29	SS Cet	D19(18)21L
del Lib	04(10)06D	U Cep	19(24)29	Z Dra	23(26)28	Z Per	D19(18)23
X Tri	D18(17)20	Z Dra	20(22)25	<b>2005 Feb 21 Mon</b>	TX UMa	D19(22)27	
TV Cas	D18(17)21	RW Tau	22(26)26L	Z Vul	L02(04)06D	U CrB	L21(15)21

X Tri	21(23)23L	<b>2005 Mar 9 Wed</b>	HU Tau	22(26)24L	U CrB	D19(19)25	
TV Cas	22(26)30D	TV Cas	04(08)05D	TW Dra	22(27)29D	<b>2005 Mar 26 Sat</b>	
<b>2005 Mar 2 Wed</b>	X Tri	D19(18)20	<b>2005 Mar 17 Thu</b>	SW Cyg	04(10)05D		
del Lib	L00(00)06D	U Cep	D19(22)27	SW Cyg	00(06)05D	Z Per	L05(05)05D
U Sge	L02(00)05	RW Tau	20(24)24L	TX UMa	01(06)05D	RW Tau	D19(15)20
HU Tau	D19(16)20	<b>2005 Mar 10 Thu</b>	U Cep	05(10)05D	Z Dra	22(24)27	
X Tri	20(23)23L	Z Vul	03(09)05D	<b>2005 Mar 18 Fri</b>	<b>2005 Mar 27 Sun</b>		
TW Dra	21(26)30D	SS Cet	D19(16)20L	del Lib	01(07)05D	U Cep	04(09)05D
<b>2005 Mar 3 Thu</b>	X Tri	D19(17)20	Z Dra	D19(21)23	<b>2005 Mar 28 Mon</b>		
Z Vul	L01(00)05	Z Dra	D19(17)20	U CrB	L19(22)28	TW Dra	04(09)05D
SW Cyg	D19(13)19	HU Tau	D19(22)24L	HU Tau	23(27)23L	<b>2005 Mar 29 Tue</b>	
TV Cas	D19(22)26	Z Per	D19(23)25L	<b>2005 Mar 19 Sat</b>	U Sge	L00(01)05D	
X Tri	19(22)23L	TX UMa	22(27)29DU Sge	L01(<<)03	U CrB	00(06)05D	
Z Dra	20(22)25	TV Cas	24(28)29D	U Cep	D19(22)26	TV Cas	03(07)05D
<b>2005 Mar 4 Fri</b>	<b>2005 Mar 11 Fri</b>	TW Dra	D19(23)28	Z Per	L04(07)05D		
del Lib	02(08)06D	del Lib	01(08)05D	Z Per	22(27)24L	Z Dra	D19(17)20
SS Cet	D19(17)21L	RS CVn	02(08)05D	<b>2005 Mar 20 Sun</b>	U Cep	D19(21)26	
HU Tau	D19(18)21	X Tri	D19(16)19	Z Vul	L00(04)05D	del Lib	L22(23)29D
Z Per	D19(20)25	U CrB	L20(24)29D	TV Cas	01(05)05D	Z Vul	L23(24)29D
U Cep	D19(23)27	Z Dra	23(26)28	TX UMa	02(07)05D	<b>2005 Mar 30 Wed</b>	
X Tri	19(21)22L	<b>2005 Mar 12 Sat</b>	Z Dra	03(05)05D	SW Cyg	L20(23)28D	
TX UMa	19(24)28	U Sge	L01(03)05D	RS CVn	D19(22)29	TV Cas	22(26)28D
U CrB	21(26)30D	SW Cyg	D19(16)20L	RW Tau	21(26)24L	TW Dra	23(28)28D
<b>2005 Mar 5 Sat</b>	RW Tau	D19(19)23	<b>2005 Mar 21 Mon</b>	Z Dra	24(26)28		
U Sge	03(09)06D	HU Tau	19(23)24L	TV Cas	21(25)29D		
Z Dra	05(07)06D	TV Cas	19(23)28	SW Cyg	L21(20)26		
Z Vul	05(11)06D	SW Cyg	L22(16)22	<b>2005 Mar 22 Tue</b>			
TV Cas	D19(17)22	<b>2005 Mar 13 Sun</b>	U Sge	01(07)05D			
X Tri	D19(21)22L	Z Vul	L01(<<)01	U CrB	03(09)05D		
TW Dra	D19(22)27	SS Cet	D19(15)20	S Equ	L04(<<)04		
<b>2005 Mar 6 Sun</b>	Z Per	19(24)25L	U Cep	05(09)05D			
RS CVn	D19(13)19	TX UMa	23(28)29D	TW Dra	D19(18)23		
HU Tau	D19(19)23	<b>2005 Mar 14 Mon</b>	Z Dra	20(23)25			
X Tri	D19(20)22L	TW Dra	03(08)05D	del Lib	L23(23)29D		
<b>2005 Mar 7 Mon</b>	TV Cas	D19(19)23	Z Per	23(28)24L			
SS Cet	D19(17)21L	Z Dra	D19(19)21	<b>2005 Mar 23 Wed</b>			
X Tri	D19(19)22	U Cep	D19(22)27	TX UMa	04(09)05D		
Z Per	D19(21)25L	HU Tau	21(24)24L	TV Cas	D19(20)25		
TX UMa	20(25)29D	<b>2005 Mar 15 Tue</b>	RW Tau	D19(21)23L			
Z Dra	22(24)27	Z Vul	01(06)05D	<b>2005 Mar 24 Thu</b>			
SW Cyg	L22(27)29D	S Equ	L04(02)05D	Z Dra	05(07)05D		
<b>2005 Mar 8 Tue</b>	U CrB	05(11)05D	U Cep	D19(21)26			
Z Vul	L01(<<)03	RS CVn	21(27)29D	Z Vul	L24(26)29D		
S Equ	L04(05)05D	del Lib	L23(23)29D	<b>2005 Mar 25 Fri</b>			
TW Dra	D19(17)22	<b>2005 Mar 16 Wed</b>	del Lib	01(07)05D			
X Tri	D19(19)21	Z Dra	01(04)05D	S Equ	04(09)05D		
HU Tau	D19(20)24L	SS Cet	D19(15)19	TV Cas	D19(16)20		
del Lib	L24(24)29D	Z Per	20(25)25L	RS CVn	D19(17)24		

012-03

20' FIELD INVERTED

CN ORIONIS      05h 52m 07.8s -05° 25' 00" (2000)

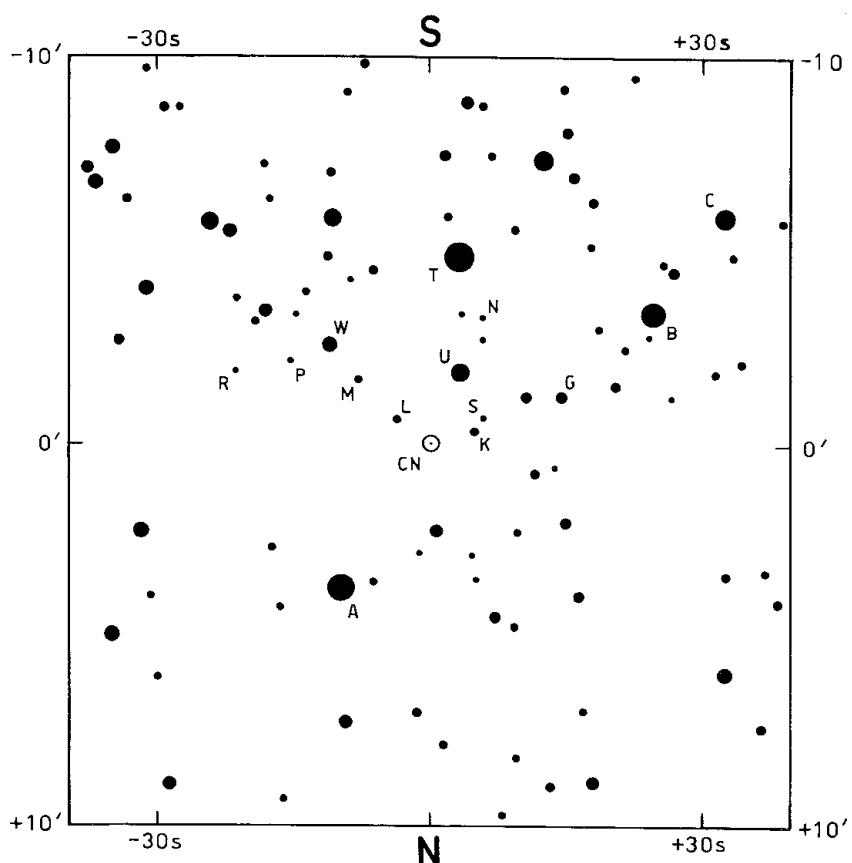


CHART:

POSS

SEQUENCE:  
T&A TYCHO 2 VJ  
OTHERS HENDEN

T 9.8      K 14.2

A 10.6      L 14.6

B 11.3      M 15.1

C 11.9      N 15.6

U 12.5      P 15.8

W 13.0      R 16.0

G 13.7      S 16.3

BAA VSS

EPOCH: 2000

DRAWN: JT 04-01-04

APPROVED: RDP

The deadline for contributions to the issue of VSSC 123 will be 7th March, 2005. 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.

Printed by RAMPrint 01604 233677

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### Nova and Supernova discoveries

First telephone the Nova/Supernova Secretary. If only answering machine response, leave a message and then try the following: Denis Buczynski 01524 68530, Glyn Marsh 01772 690502, or Martin Mobberley 01284 828431.

**Variable Star Alerts** Telephone Gary Poyner (see above for number)

**BAAVSS web pages:**<http://www.britastro.org/vss>

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