

**British Astronomical Association**



# **VARIABLE STAR SECTION CIRCULAR**

**No 99, March 1999**

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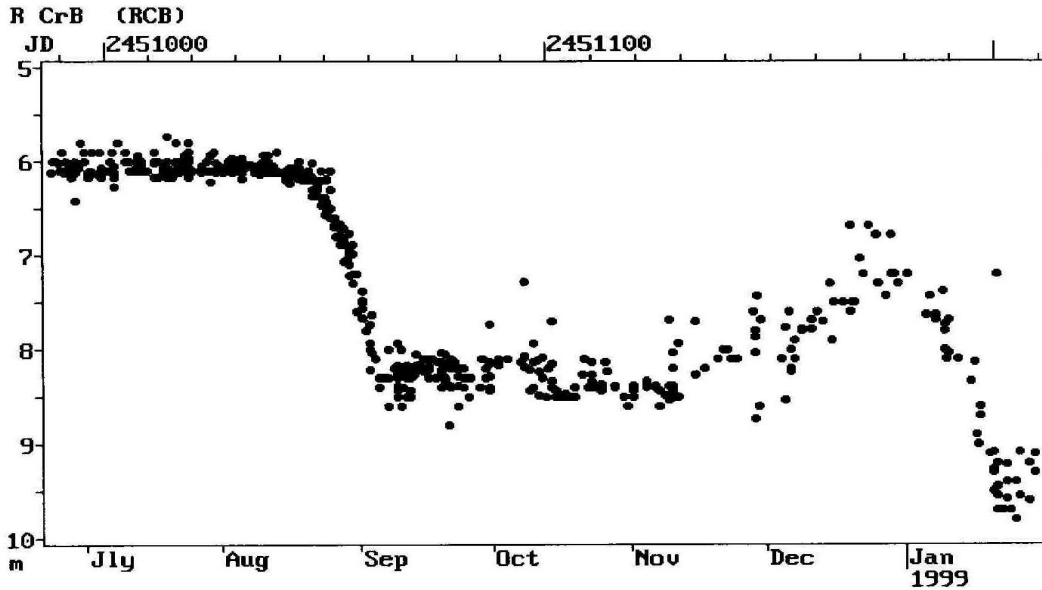
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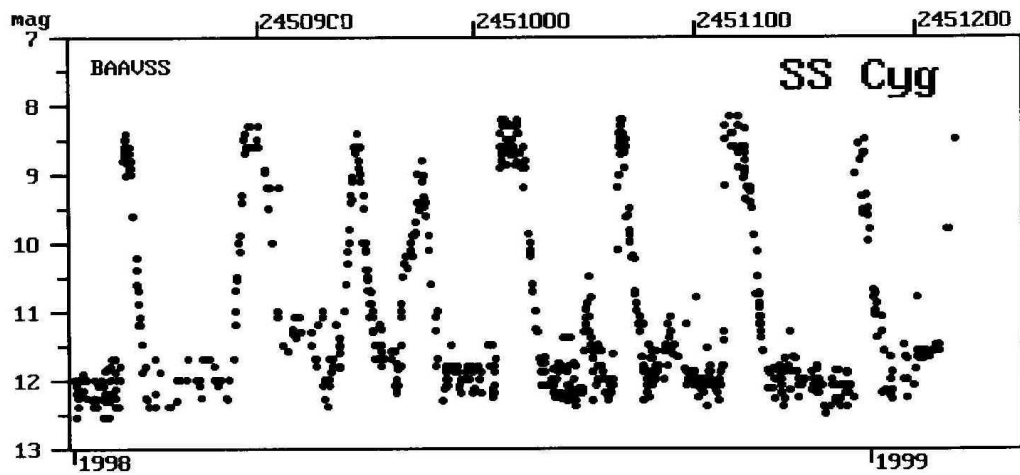
**Office: Burlington House, Piccadilly, London, W1V 9AG**

# LIGHT CURVES

DAVE MCADAM



**R CrB observers in 1998 and 1999;**- S W Albrighton, K G Andersson, A R Baransky, R J Bouma, L K Brundle, Tom Cragg, J S Day, R C Dryden, M J Gainsford, D Gill, B H Granslo, G M Hurst, A J Johnston, Miroslav Komorous, T Markham, J Meacham, I A Middlemist, Volodymir G Mormyl, E Muyllaert, G Poyner, P Schmeer, J D Shanklin, G Stephanopoulos, J Stubbings, M D Taylor, J Thorpe, J Toone, Vince Tuboly, M Westlund, P Williams.



**SS Cyg 1998 to 1999.** 823 observations by:- S W Albrighton, A R Baransky, R J Bouma, L K Brundle, M J Gainsford, D Gill, B H Granslo, G M Hurst, Miroslav Komorous, H W McGee, J Meacham, E Muyllaert, G Poyner, G W Salmon, P Schmeer, J D Shanklin, M D Taylor, J Toone, Vince Tuboly.

# OBSERVING CAMPAIGN FOR QR AND (RX J0019.8+2156)

PETR SOBOTKA AND DR VOJTECH SIMON

## Introduction

V. Simon, Ondrejov Observatory, and the MEDUZA Group have announced an observing campaign for QR And. Ondrejov Observatory is a professional astrophysical centre in the Czech Republic. MEDUZA is a group of observers included in the B.R.N.O. (Brno Regional Network of Observers - the Variable Star Section of the Czech Astronomical Society).

## Why Observe QR And ?

QR And is a very interesting, and relatively bright variable star in the north sky. It has been detected as a soft X-ray source quite recently, and has been identified with a variable star (Beuermann et al. 1995, A&A, 294, L1). As QR And is not included in the observing programmes of any other variable star societies, no long-term light curves exist. Professional astronomers need more data to explain its behaviour, and for this reason we have decided to invite all observers to join in a worldwide campaign to monitor this interesting variable star.

## Optical Variability of QR And

We chose some pieces of information from the only existing long-term light curve (see overleaf), deduced from the Harvard and Sonneberg archival photographic plates (Greiner and Wenzel, 1995, A&A 294, L5):

- (a) The orbital modulation ( $P=15.8$  hours), with an amplitude of about 0.5 magnitudes, resembles a Beta Lyrae type variable star, i.e. the brightness varies smoothly; there are no flat portions in the light curve. The modulation is highly variable from cycle to cycle (Meyer-Hofmeister et al., 1998, A&A, 331, 612). The following lightcurve elements were derived:  $\text{Min. (hel.)} = 2\,435\,799.247 + 0.6604565 * E$ , which is valid at least for the years 1955 - 1993.
- (b) Irregular fluctuations occur, on timescales of weeks to months, of amplitude about 1 magnitude.
- (c) There are also long-term variations, seemingly non-periodic, with timescales of up to 20 years, and an amplitude of 2 magnitudes.

There are two large optical brightness jumps of about 1 magnitude. The rise time of the jump in 1969 is shorter than 10 months, whilst the jump in 1931/32 has a rise time of 14 months. Both of these intensity jumps are followed by a slow relaxation, which continues for approximately 20 years. Whether or not there was a similar jump at the end of the last century, which would imply a nearly periodic recurrence time scale of around 40 years, cannot be determined due to the sparse coverage, but certainly, at these times the object also showed the full amplitude of variability ( $>1$  magnitude).

Many of the seasonal means are averages over irregular fluctuations. These variations occur on timescales of weeks to months, and the variability patterns are different from year to year. Thus, a considerable part of the scattering can be assigned to these irregular, short-term fluctuations with the resulting mean being dependent on the different coverage of bright and faint episodes.

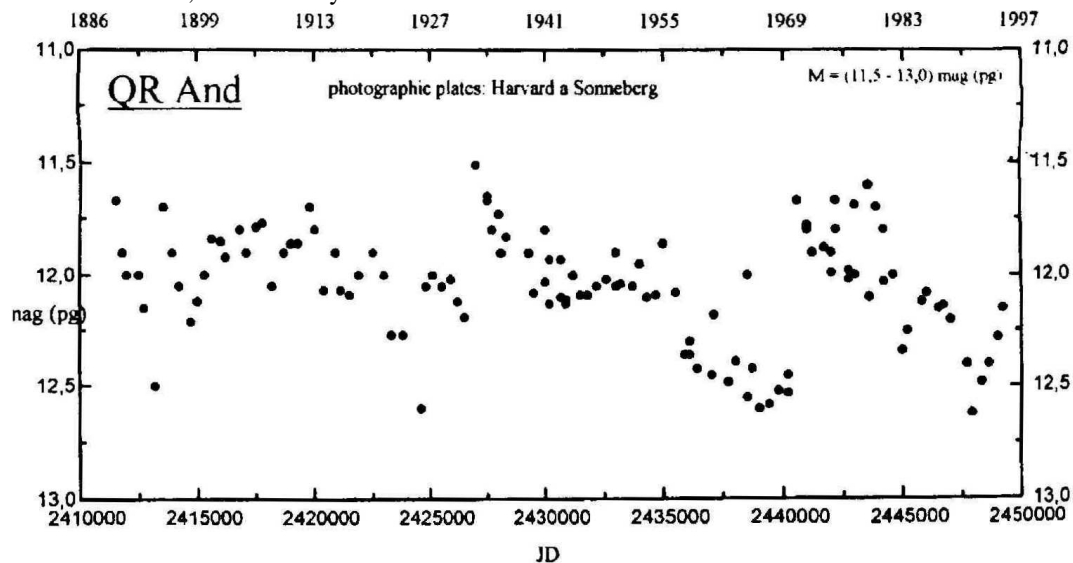
## Why is QR And so Unique?

QR And is a member of the group of the so-called supersoft X-ray sources. According to the current model (van den Heuvel et al., 1992, A&A, 262, 97), these objects are close binaries, similar to 'classic' cataclysmic variables (CV), except that the mass-donating star is of a higher

mass. Matter flows from the more massive star onto the less massive companion. This phase is a brief episode in the evolution of a binary - the mass transfer rate is extremely high at this time, much higher than in a classic CV, and the mass-losing star tends to become less massive than its companion. Due to the relatively short duration of this phase, there is a very small chance of detection. QR And is one of the rare exceptions.

The high mass transfer rate makes the accretion disc much more luminous than in common CVs. Moreover, the large mass transfer ensures that steady-state hydrogen burning on the surface of the white dwarf is maintained. This thermonuclear reaction is a powerful source of extremely soft X-rays, a feature not imitated by any other kind of binary with an accreting compact object. A proportion of the X-ray radiation is absorbed by the accretion disc, which then increases in temperature, and the energy is re-radiated in the optical region. The luminosity of 'super-soft' binaries comes therefore not only from the accretion process, but also from the re-emitted radiation, and this results in the system being much brighter than a classic CV.

Unfortunately, although 'super-soft' binaries are a very powerful source of soft X-rays, they are rarely observed, because this wavelength range is so easily absorbed whilst travelling through the interstellar medium. Acquiring as much information about the variation of QR And in the optical region will make it easier to identify more distant members of this class of binaries, whose X-rays have been absorbed in the interstellar medium too much to be



detected. The well known variable star V Sge may be a promising candidate (Steiner and Diaz, 1998, PASP, 110, 276).

### How to Observe and Where to Send Observations

Because of variability on diverse timescales it would be advantageous to make several visual estimates or CCD measurements during each night, but if this is not possible, then single observations will also be of value. Please send all visual observations to [sobotka@physics.muni.cz](mailto:sobotka@physics.muni.cz) and all CCD measurements to [simon@sunstel.asu.cas.cz](mailto:simon@sunstel.asu.cas.cz). If you do not have access to e-mail, send your observations to Petr Sobotka, Nicholas Copernicus Observatory, Kravi hora 2, 616 00 Brno, Czech Republic. A chart for QR And has been

compiled, using the Tycho Catalogue (Hipparcos) and GSC data (see below). QR And varies between 11.5 - 13.0 mag(pg). Its amplitude in the visual region is not known, therefore comparison stars cover the broad interval 9.98 - 13.9 mag (V). Whilst the precision of GSC magnitudes is rather poor, all comparison stars will be future targets for accurate photometry. Our database contains not only reduced magnitudes and times of estimates, but the records of the estimates as well. In this way we ensure that it is possible, at any time, to re-process the content of the database, so taking account of better measurements of the magnitudes of comparison stars.

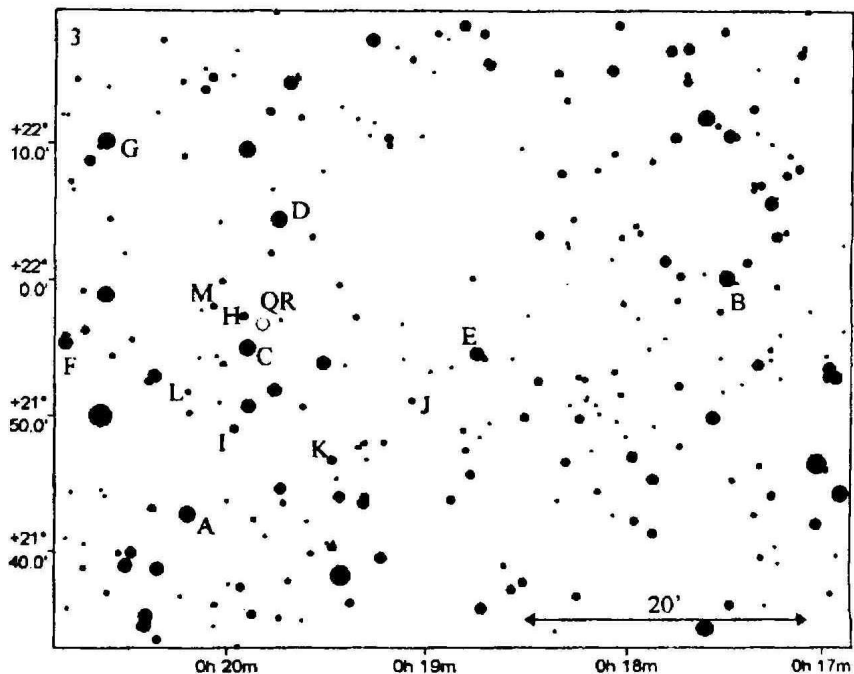
### Observation Form

Please, send all data in the following format:

Position	1	11	25	35	55	65
Entry	Star name	Julian Date	Magnitude	Date (UT)	Observer's Code	Estimate or Estimates
Example	QR And	2451139.256	11.28	1998-11-21.756	PM	E4V2F, E4V9G

The Julian date and date are rounded to three decimal places and magnitude is rounded to two places. The observer's code will be assigned to him (her) after the receipt of the first estimates. In the case of more than one estimate at the same time, please include all of them on the same line, separated by commas. For comparison stars, please use the characters given in the MEDUZA chart below. If the estimate is unsure, write a colon. Please include your full name, address and e-mail address. For CCD measurements, use comparison star 'C' (GSC 1185:1414, V= 10,55 mag, B-V= 1,46 mag) as a check star.

### MEDUZA CHART FOR QR AND



	V	B-V
A	9.98	1.18
B	10.29	0.59
C	10.55	1.46
D	10.74	1.37
E	11.01	0.75
F	11.4	
G	11.9	
H	12.5	
I	12.8	
J	13.0	
K	13.3	
L	13.5	
M	13.9	

## CHART NEWS

JOHN TOONE

The following revised charts are now available from the Chart Secretary:

**186.03 IP Peg** (Formerly 186.02 (JT 1-8-98))

The position of IP Peg on the 30' and 10' field charts has been adjusted, whilst the sequence remains unchanged.

**203.02 FG Sge** (Formerly 203.01 (GMH 10-10-92))

New 1 degree and 15' field charts have been drawn. Comparison stars A, and 11 to 15 inclusive, have been added to extend the sequence down to magnitude 16.5, whilst the magnitude of star 10 has been amended from 13.7 to 14.3.

**230.01 UU Aur** (Formerly MDT 1984 Apr 09)

Comparison star F (OX Aur, 5.94 - 6.14, type Delta Scuti) has been dropped, and star N (SAO59230, listed as star F on the MDT 1972-11-11 chart) has been re-introduced with an assigned magnitude of 6.6, which matches the AAVSO value for this star.

**231.01 X Cnc** (Formerly MDT 1984 Apr 8)

Comparison star G (FZ Cnc, 6.3 - 6.5, spectral class M4) has been dropped, together with star A, which is too bright to be useful in estimating X Cnc.

**235.01 SX Lac** (Formally MDT 1974-07-28)

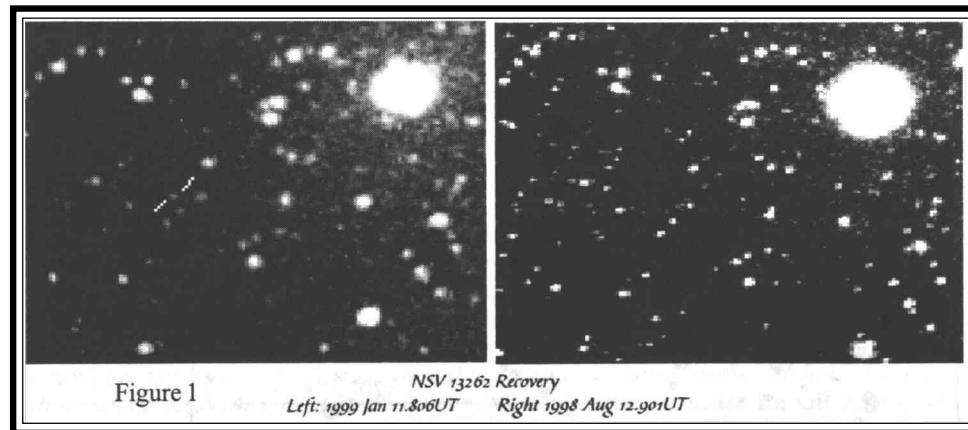
A new 9 degree field chart has been drawn, whilst the sequence remains unchanged.

## NSV 13262 DETECTED IN CCD NOVA PATROL

GUY HURST

In July 1998, as part of the UK Nova/Supernova Patrol, I commenced a search for novae using a 50mm lens operating at f1.8 and the Starlight Xpress MX516 CCD camera. The period to December 1998 was largely experimental, without comprehensive checking, but from January 1999, I began checking in the hope I could detect an intruder to magnitude 9, or possibly fainter.

The 5 second exposures can reach magnitude 12 in very good conditions, and cover an approximate field of view of five degrees. On an exposure of the Deneb field, obtained on 1999



NSV 13262 b IR Obj recovered by Guy Hurst

20h 43.7m +44 29' (2000)  
 Range: 10.2 - (12.3?)  
 Seq:A-D Tycho;rest GSC

A 10.01  
 B 10.32  
 C 10.58  
 D 11.01  
 E 11.60  
 F 12.10  
 G 12.30

Seq: TA990131

Chart number: 109  
 P - Print chart  
 F - Forward one chart  
 B - Back one chart  
 E - Exit

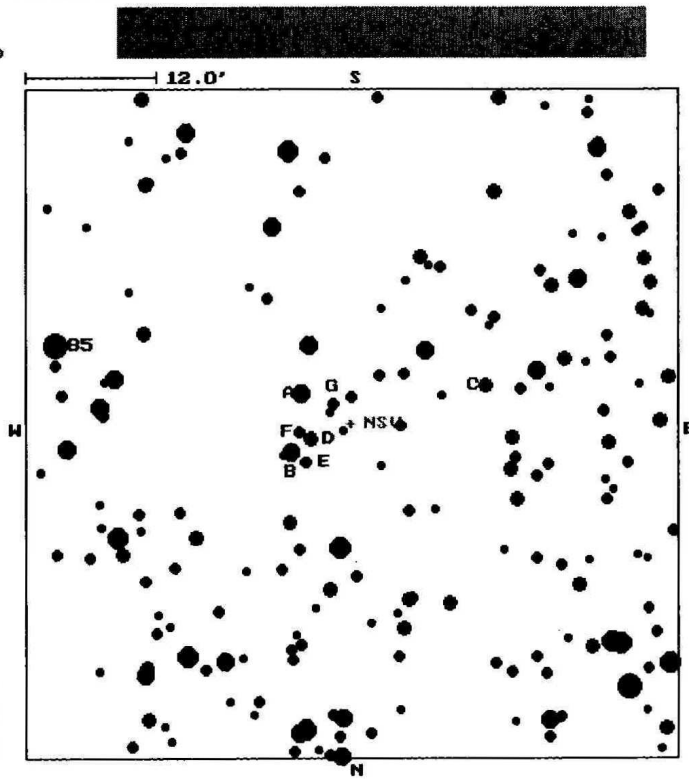


Figure 2

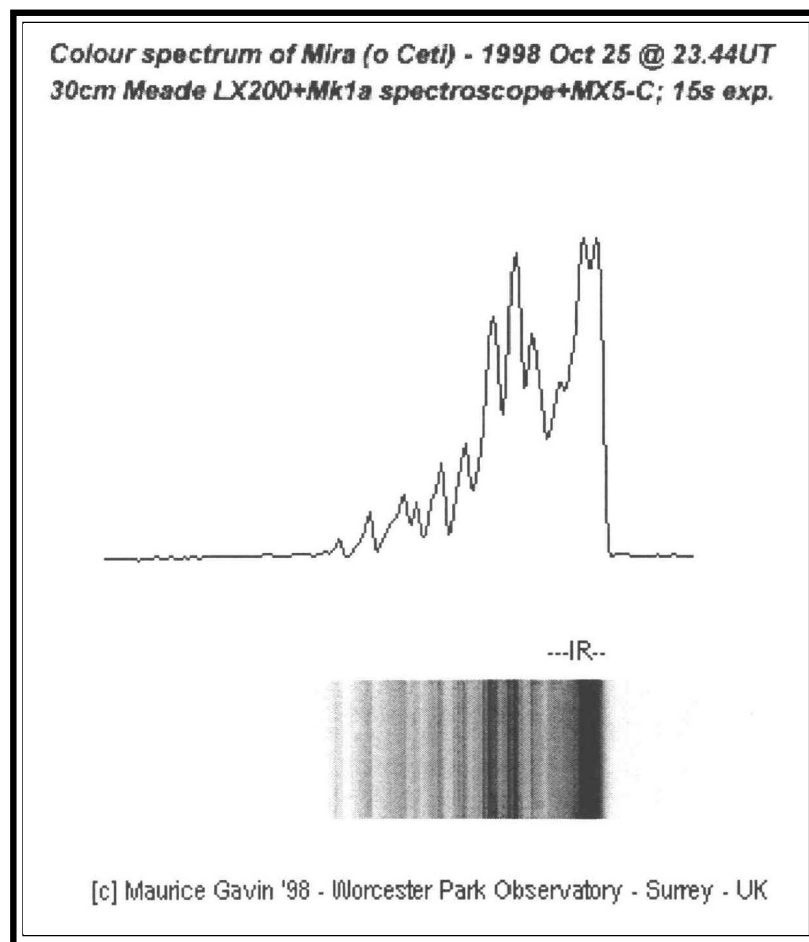
Jan 11.81UT, I detected a variable object near Deneb. The star, located at: RA 20h43.7 DEC +44 29 (2000), was of magnitude 10.7, whereas on 1998 Dec 28.754UT it was near the limit at 11.6. In response to my e-mail appeal under reference Q1999/003, Steven Foulkes recorded it on 1999 Jan 13.775UT at 10.7 (LX200). Tom Boles also measured the position: 1999 Jan 16.738UT as: RA 20h43m40.6s DEC +44 28'38.1"(2000).

Using Guide 7.0 software, it seemed that my suspect was GSC 3178.00545, but I noticed there was also a suspected variable, NSV 13262, plotted further to the south east. This had a catalogued range of 12.3 - 12.6, which seemed too faint for my candidate. However, I decided to make sure, and I traced the original discovery paper for the NSV object entitled 'Near-Infrared Photometry of Unidentified IRC Stars' (Lockwood, ApJ., 192, 113L, 1974). This contained a finder from the Palomar Sky Survey, and this confirmed that my suspect, the GSC star and the NSV object were all one and the same. Looking back over unchecked images taken in 1998, in the period 1998 August to 1999 January, there was an apparent sharp brightening on the exposure of 1998 Nov 4.857UT to magnitude 10.2, whereas on 1998 August 12.901, the object was not recorded to a limit of 12.3. Even allowing for the possibility that it was bright due to the spectral response of my equipment, and the very red nature of the object, it does seem to have a substantial amplitude compared with the NSV catalogued range of 12.3-12.6. Figure 2 shows a new chart and sequence, from which I hope some readers will obtain and submit estimates to me. Figure 1 shows a comparison of CCD images, which I would stress are highly magnified, and therefore do show rather fuzzy images for which I apologise. I am still learning the art of CCD work!

## THE SPECTRUM OF MIRA

MAURICE GAVIN

Whilst most spectra are simply dissected for the secrets they can reveal, the spectrum of Mira (archetypal LPV) is physically attractive too, resembling a hanging curtain or series of cylindrical columns. The 'fluted' appearance, common to cooler M type stars, is caused by molecules in the stellar atmospheres - principally titanium oxide (TiO). Hydrogen emission lines are also present in Mira's variable spectrum, but are unresolved in the adjacent low resolution spectrogram. A colour version is on the BAA VSS web site. Although Mira's spectrum extends into the UV, the bulk of the radiation is confined to the red and near-infrared (IR) end which CCDs easily record. An IR-block filter was used (killing radiation longer than about 750nm), but such is the intensity of Mira's IR that it punched through the filter virtually unabated! A regular camera lens (imaging the spectrum onto the CCD) is incapable of sharply focusing both visible and IR in the same exposure, and the twin IR peak in the histogram plot is the slightly defocused image of the star. The large magnitude range of LPVs is caused by the peak radiation sliding into the IR region beyond visual detection.



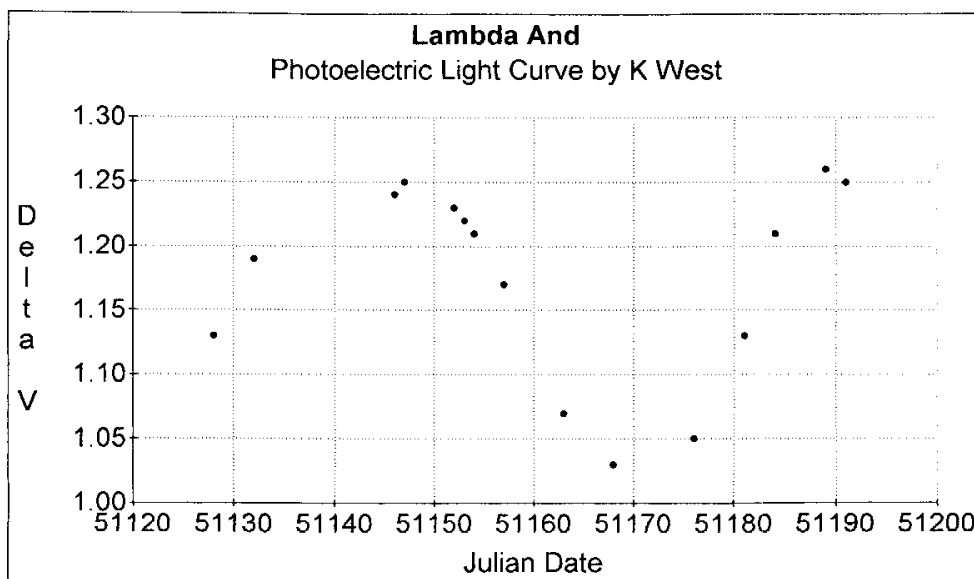


## SPOTTY STARS- A PLEA FOR AN EXPLANATION

KEVIN WEST

According to the sketchy information that I have, Lambda And is a member of the RS CVn class of variables, more descriptively known as spotty stars. These systems comprise a relatively close binary pair in which one partner, a sub-giant, has been 'spun up' by its proximity to a less evolved star. The result is that the sub-giant is rotating much faster than it would normally. For reasons not fully understood this causes huge spots to form, and these are detectable photometrically. From an old article by Douglas Hall<sup>1</sup> the orbital period is given as 20.52 days, but I'm not sure whether this also applies to the period one would observe as the spot rotates on the sub-giant.

The extended spell of good skies during November and December 1998 enabled me to obtain the (patchy) light curve shown below. It shows a period closer to 50 days. Can anybody explain this apparent anomaly, and provide me with some up to date information? Perhaps others are observing these stars and could use the data.



### References

<sup>1</sup> Photoelectric Photometry Handbook 1, Douglas Hall.

Kevin West, 5 Edward Street, Ryde, Isle of Wight, PO33 2SH.

Tel: 01983 614591

Email: kwest@ryde.prestel.co.uk

## **SS AUR - RECENT ACTIVITY**

**JOHN TOONE**

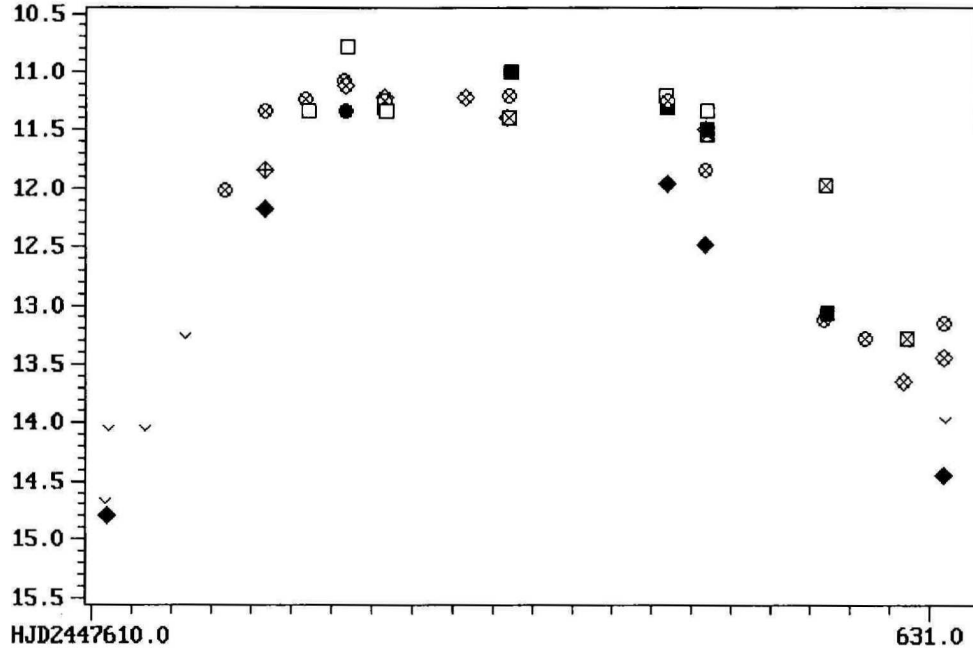
The mixed spell of weather that prevailed over the UK during the period December to February produced an unusually large number of clear, and partly clear, nights (compared to normal weather patterns for winter months), and this coincided with good activity in several bright dwarf novae. U Gem had a long outburst just before Christmas, and was followed almost continuously from when it rose above magnitude 13.8 on the 10th December, until it dipped below the same brightness 16 days later. SU UMa commenced rising to a supermaximum on the 6th January, and did not fade back to normal minimum until the 21st January. The rise to maximum was interrupted by a brief mini-fade of 0.2 magnitude which resembled the onset of the 3 day oscillations previously reported for this star.

The most interesting activity occurred, however, in SS Aur, which produced an unusually long outburst in the second half of December and took an extraordinarily long time to reach maximum. The star was caught rising on the 15th December, and had reached magnitude 12.5 by the following night. The rate of rise then slowed down significantly and it took a further 8 days to finally reach a maximum magnitude of 10.9. The width of the outburst was measured at 13 days above magnitude 12.0, which equals the longest outburst previously recorded by the VSS, which was in March/April 1989. The AAVSO however, have reported two longer outbursts, each lasting 14 days above magnitude 12.0. These occurred in May/June 1916, and September 1942, when most of our observers were otherwise engaged (the battle of Jutland was underway and preparations were being made for the Somme and El Alamein offensives), and the VSS only partly observed the second one.

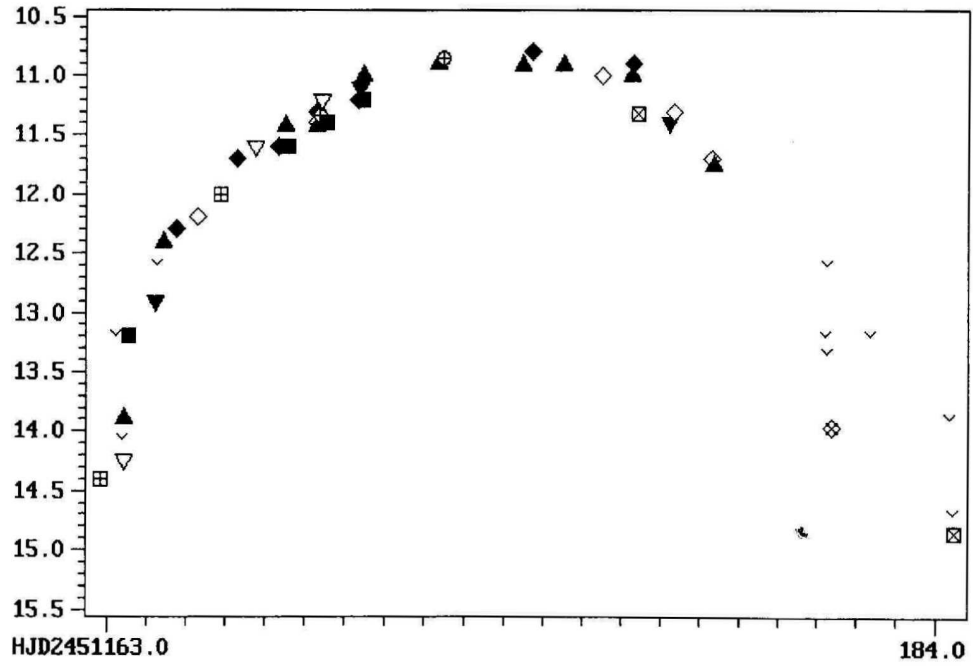
Light curves of the 1989 and 1998 outbursts are shown for comparison, on the opposite page. Both outbursts lasted 18 days above magnitude 14.0, but their shapes are very different. The 1989 outburst was similar to a normal long outburst with a rapid rise and much slower fade, whilst that of 1998 was pretty much a mirror image of 1989. VSS data accrued on SS Aur indicates a mean period of 51 days between outbursts, but the 1998/99 apparition has been quite eventful so far. In October there was a normal short outburst, which was followed 33 days later by an anomalous outburst. Then came the December event, followed just 37 days later by another rather faint anomalous outburst. The average interval between outbursts so far this apparition, has been 37 days. The star has also been rather bright (around magnitude 14.5) at times in-between the outbursts. SS Aur has in the past (in 1929/29, 1970/71 and 1983) shown rapid erratic variations but the present activity is more akin to speeded up normal behavior.

It will be interesting to see how long the current active state will continue and observers are urged to continue monitoring the star throughout the spring and summer months as long as possible. It is worth reminding observers that important estimates can be secured during the months of June and July from our latitude. If you can see Capella and are equipped with an 8" telescope it is possible to see comparison L (12.6) throughout these twilight-ridden months. Although SS Aur has been followed for over 90 years now, it continues to surprise and reward the visual observer.

### SS AUR 1989



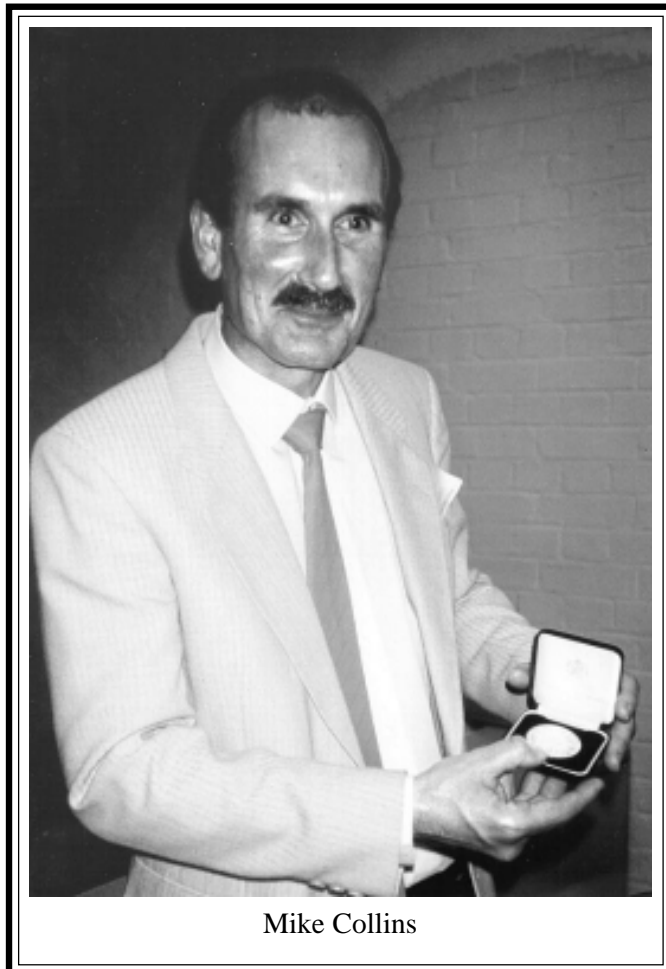
### SS AUR 1998



## MIKE COLLINS' DISCOVERIES

GUY HURST

Mike joined the UK Nova/Supernova Patrol in September of 1986 and initially he was allocated the customary six nova areas for visual search. However he later decided to move to checking wider areas of the Milky Way for novae by photographic means. The standard equipment he uses comprises a 135mm telephoto lens which broadly matches the ten degree fields of each nova search area. Kodak 2415 film is used and it seems this turned out to be significant later in the detection of red variables, which showed up as 'bright' when compared with earlier surveys, eg Harvard, which tended to use blue plates. On a number of occasions Mike has come close to finding a nova, and it has only been a prior announcement which has beaten him to it. However he has been extremely successful, as a by-product of the nova hunt, in the discovery of variable stars. The first were found in 1989, and during that year 31 possible



Mike Collins

variables were recorded. Where negatives were submitted to the Editor, preliminary designations were assigned, either TAV, where variation was confirmed, or TASV if suspected only and further investigation was needed. As at June 1998, 157 stars have been found, although some are old suspects, normally 'NSV' objects, which have been independently recovered. Of this total 93 objects still need to be investigated and documented but even amongst the remainder we still need further observations to determine their type. Our aim is to achieve enough results to prepare a case for the object to be formally entered in the GCVS and there is an enormous amount of work to do! Please contact Gary or myself if you can help!

# CHARTS FOR MIKE COLLINS VARIABLE STARS

KAREN HOLLAND

Over the next few circulars charts will be included for some of Mike's discoveries - all of these stars are under-observed! Please send observations to Dave McAdam, but copy to Mike for his information too.

For this circular, the chart for TAV J0550+543 has been included (see overleaf). Illustrated below is the light curve obtained so far, Figure 1, and the light curve with Mike's least squares fit to a sinusoid, Figure 2.

These plots are on the BAAVSS web page at <http://www.telf-ast.demon.co.uk/gifm/00726c.gif> and at <http://www.telf-ast.demon.co.uk/gifm/00726a.gif>

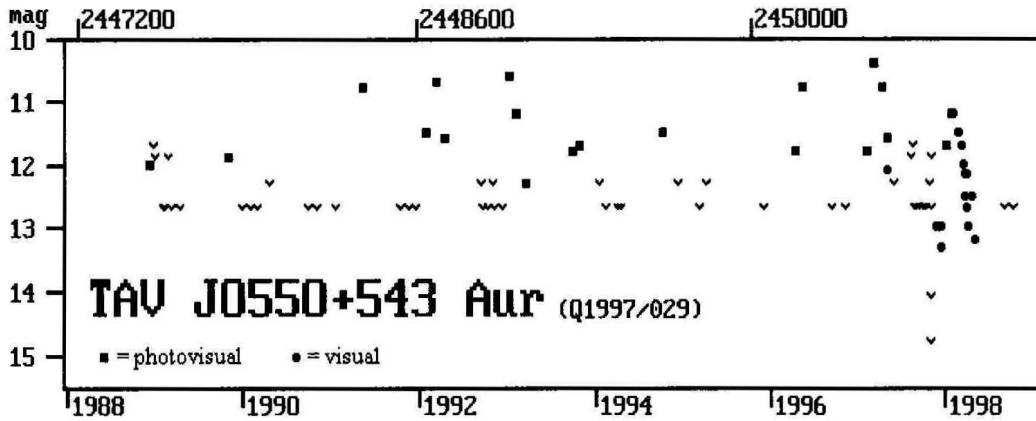


Figure 1

TAV J0550+543 Aur (Q1997/029) mv to mpv colour index applied, least-squares sinusoid fit

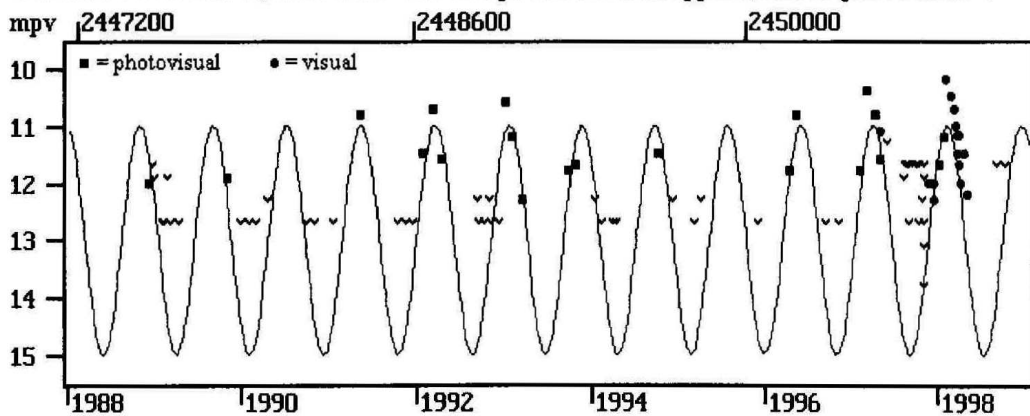


Figure 2

89 observations by;- K G Andersson, M Collins, G M Hurst, C Newman, G Poyner, M Westlund.

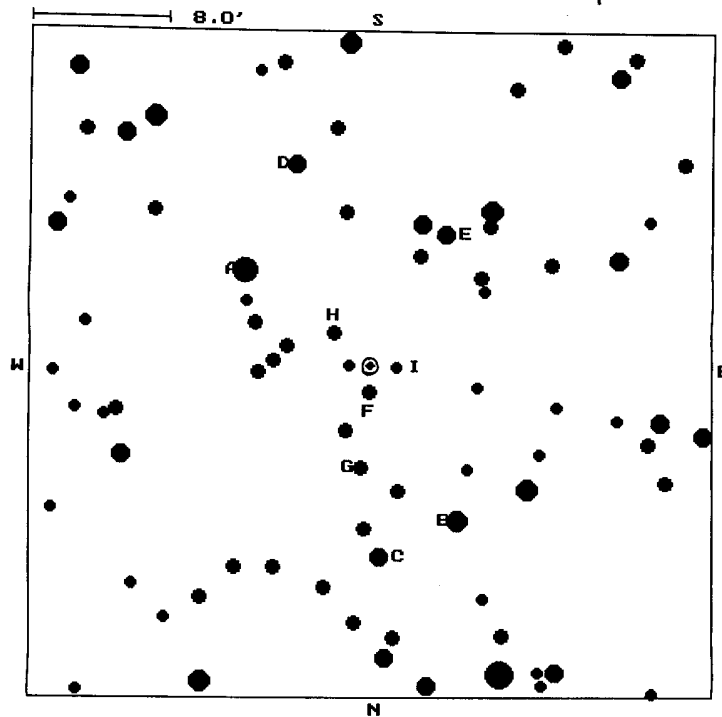
(B) TAV J0550+543

RA 05<sup>h</sup> 46<sup>m</sup> 0 DEC +54° 22' (1950)  
05<sup>h</sup> 50<sup>m</sup> 10<sup>s</sup> +54° 22' 51" (2000)

Magn: 10.4 - [13.9?

Type: Unknown

Discovered by Mike Collins in UK Navy Patrol photos 1997 Mar 5.9 UT



Sequence: GSC V-band mag  
Mike Collins

Chart: M. Collins

A	9.40
B	10.20
C	10.70
D	10.90
E	11.30
F	11.70
G	11.90
H	12.30
I	12.70

970427

TA Ref: R280-282

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## THE 1998 MEETING OF THE VARIABLE STAR SECTION (CONTINUED)

TRISTRAM BRELSTAFF

After lunch, as the first scheduled speaker, Tonny Vanmunster had not yet arrived, Paul Roche of Sussex University spoke on the subject of 'Echo-sounding the Accretion Disk of Her X-1'. Paul is a member of an international team attempting to determine the mass of the neutron star in the Her X-1 system.

The masses of neutron stars are currently a subject of great theoretical interest. On the one hand, we have very well-determined masses for those neutron stars in binary pulsars, all of which are close to 1.45 solar masses. On the other hand, we only have rather inaccurate masses for the neutron stars in X-ray binaries, and these show a much greater range with some, such as Her X-1, possibly being as small as 0.7 solar masses. The aim of the international team is to use high time-resolution observations to model the Her X-1 system, and to derive a more accurate mass for the neutron star.

Her X-1 is the X-ray counterpart of the optical variable star HZ Her. The Her X-1/HZ Her system is thought to be a binary consisting of a relatively 'normal' A-type star ('HZ Her'), which produces most of the optical radiation of the system, the neutron star ('Her X-1') which produces the X-rays, and an accretion disk surrounding the neutron star which is visible in the ultra-violet.

Paul explained that some of the key inputs to the model were parameters defining the structure and orientation of the disk. They hoped to determine these parameters by observing ultra-violet 'echoes' of the X-ray pulses from the neutron star. These X-ray pulses are emitted at intervals of 1.24s, and are relatively narrow. However, some of the energy from them is absorbed by the disk and re-radiated as 'echoes' in the ultra-violet and, as each pulse takes longer to reach the outer parts of the disk than the inner parts, the echoes we see are broader than the original pulses. It is this broadening that they are using to constrain the structure and orientation of the disk in their models.

To do this they need lots of high time-resolution observations at many wavelengths. In 1998 they were allocated large amounts of observing time on the Rossi X-ray Timing Explorer, and Extreme Ultra-violet Explorer satellites, the Hubble Space Telescope, as well as on the Keck, William Herschel, Calar Alto and Mount Palomar Telescopes. However, further data is required and more observations are planned for 1999. Simultaneous optical monitoring of HZ Her by amateurs would be very useful. Paul added that preliminary modelling suggested that the mass of the neutron star was in the region of 1.5 solar masses, in agreement with the binary pulsar results.

The next speaker was Zach Ioannou of Keele University who spoke on 'Outbursts of Dwarf Novae: Science with Medium-size Telescopes'. Zach had been modelling the dwarf novae in outburst using CCD observations made by various professional astronomers at Keele and St Andrews, as well as by the amateurs David Strange and Nick James.

The first star he discussed was HT Cas which had been observed during its 1995 outburst. The eclipses are narrow at minimum, become broader at maximum and then narrow again on

the fade. The development of the eclipses during the outburst is best modelled by an 'outside-in' type of outburst, in which the rim of the disk brightens first and the brightening then moves inwards. Timings of eclipses on three consecutive nights also show a peculiar 80s deviation in O-C on the second night, which is rather difficult to explain by any of the available models.

The second star Zach discussed was IP Peg, which was observed during its 1997 outburst. This star shows markedly asymmetric eclipses at minimum: the fade is very steep and then the rise starts slowly but then suddenly becomes much steeper. In addition, the out-of-eclipse level before the eclipse is noticeably brighter than the one after. Zach interpreted these features as due to eclipses of both the white dwarf and the hot-spot. As the outburst starts, the eclipse becomes more symmetrical, and the rise straightens out somewhat. There is also a suggestion of a secondary eclipse at phase 0.5 in some of the observations. By the time the outburst has reached maximum the eclipses have become broad and shallow and there is now a marked hump at phase 0.5. Outside of eclipse there are flares, which suggests the presence of tidal instability in the disk. Modelling suggests that the disk is strongly flared (ie: it has a high outer rim) and that the outbursts are of the 'outside-in' variety. The disk seems to undergo quite dramatic changes during the outbursts of this star.

Then Andy Hollis, the director of the BAA Asteroids and Remote Planets Section, rose to talk about 'Automating a Telescope for Photometry'. Andy had recently finished converting his 14 and 17-inch Cassegrain telescopes, which he had previously been using for manual photoelectric photometry, over to automatic operation. Both of these telescopes are mounted on the same German mount. They are controlled with a BBC Micro running software written by Peter and Ann Ells for the Jack Ells APT. However, Andy has adapted the software to work with DC rather than pulse counting techniques, and has also made a few other changes to streamline its operation.

Since completing the conversion, he had only had one night during which he could observe. This, he had used to monitor two constant stars near Procyon. The resulting measurements had an accuracy of about 0.02 mags with only one or two wild points (these Andy blamed on aircraft condensation trails).

Andy stressed the importance of having a systematic approach to testing and correcting the system. In particular, he warned against making adjustments in the middle of observing runs. Instead you should keep a log of any problems noticed and only make the required adjustments between runs.

Andy summed up by saying that the great advantage of his new automated set-up was that it only took him 15 minutes to set it up at the start of a run and another 15 minutes to close it down at the end - in between he was free to do other things, like sleep!

The last speaker before the tea break was Nick James who spoke on the subject of 'Linux and the Variable Star Observer'. Nick had recently been appointed the 'official' distributor of the Starlink CD-ROM for the amateur community. The Starlink software collection is a suite of astronomical software that is used by UK professional astronomers to perform image analysis, time series analysis and various other tasks. The original Starlink software ran under Unix (a computer operating system popular with academics) but the software has been ported to LINUX (a version of UNIX suitable for running on PCs), and it is this version that is distributed by Nick.



Nick showed some screen-shots of PISA, one of the Starlink programs. 'PISA' stands for 'Position, Intensity, Shape Analysis' and this program can be used to identify all the star images in a CCD image and produce a file of their intensities and x,y co-ordinates. Nick said that on his 200MHz Pentium PC it could process an image of M13 in about 2s.

Because the Starlink programs have been produced and extensively used by professional astronomers, they tend to be based on the best-available algorithms and be well-adapted to handle large data sets. In addition, they usually give error estimates on the results they produce. They are also generally well-documented.

If you would like to run Starlink programs on your own PC then you will need to install 'Red Hat' Linux. This will probably mean partitioning your hard disk and then installing Windows in the lower partition and Linux in the upper one (Nick pointed out that when you buy a new PC your supplier should be able to do this for you). You will then be able to dual-boot into Windows or Linux as you require. Another option is to buy a second PC just for Linux. One of the great advantages of Linux is that it is free. Another is that it is relatively small, however, it is still too large to download over the Internet.

To be continued...

## **BAA VSS WEB PAGE UPDATES**

**DAVE MCADAM**

### **BAAVSS home pages      <http://www.telf-ast.demon.co.uk/Update Notice No. 3>**

The following items have been added since 14/12/98:

V751 Cyg: A Neglected VY Scl star : G Poyner

3C273 - Low-res Spectrum - An amateur first? : M Gavin

U Gem - Eclipse Ephemeris 1999 : W J Worraker

New Current lightcurves;- Z And, FO And, S Aps, TT Ari, SS Aur, TAV J0550+543 Aur, Z Cam, XX Cam AM Cas, V770 Cas, NSV 165 Cas, TAV0033+59 Cas, DY Cen, NSV14680 Cep TAV2034+61 Cep, SY Cnc, R CrB, EsB365 Cru, SS Cyg, CH Cyg, V405 Cyg, V751 Cyg LD22 Cyg, UX Dra, AB Dra, AG Dra, U Gem, AH Her, AY Lyr, U Mon, CN Ori CZ Ori, V1159 Ori, DY Per, TASV0327+44 Per, V Sge, RZ Sge, FG Sge, SU Tau Z UMa, SU UMa, ER UMa, Z UMi, SS Vir, WW Vul

5 Observing charts; AG Dra (080.02), V358 Lyr (240.01), FG Ser (085.02)

### **BAAVSS home pages      <http://www.telf-ast.demon.co.uk/Update Notice No. 4>**

The following items have been added since 14/01/99:

T Tau - Emission lines in Low-res Spectrum : M Gavin

New Current lightcurves;- RX And, SS Aur, TT Boo, Z Cam, AM Cas, NSV165 Cas, NSV203 Cas, V362 Cep V451 Cep, R CrB, SS Cyg, V1057 Cyg, PZ Gem, X Leo, Nova 1998 Mus, CN Ori CZ Ori, RU Peg, TZ Per, RR Tau, PKS0422+004 Tau, TX Tri, SU UMa

5 Observing charts; UU Aur (230.01), X Cnc (231.01), SX Lac (235.01), IP Peg (186.03), FG Sge (203.02), Markarian 421 (JT840909)

Plus latest lists, Long-term lightcurves updated, 6 Other detailed lightcurves, observing totals, and other details

## **FILTERED PHOTOMETRY - PREPROCESSING AND PHOTOMETRY**

**GRAHAM SALMON**

In my last article, I dealt with some of the problems encountered in acquiring the image frames containing the variable star, and one or more comparisons. We now have to extract the information and derive a magnitude difference between one and the other(s). The steps are:-

- a *Subtract the dark frame.*
- b *Apply the flat field.*
- c *Carry out the photometry.*
- d *Enter the results on a chart*

Excellent though I have found my Starlight Express SXL8 to use, when it came to these processes, it posed some problems. Having taken several dark frames during the observing sessions, when they were averaged and subtracted from the image frame the level of the resultant was sometimes zero. We have fairly dark skies in this part of Cornwall, but not that dark! For some reason, despite good temperature stability, the level of the averaged field was greater than that of the image, so it should have produced a negative value, but was limited to zero. This meant that the photometric results were taken from a false zero which affected the measured magnitudes of the fainter stars. Also, when carrying out the photometry, the cursor could only be positioned with the mouse, and as it had to be moved pixel by pixel to find the greatest reading, it created considerable wrist-ache.

I therefore bought the QMips32 software from True Technology, which is a programme written by Christian Buil et al, and contains a wide variety of image processing commands, including some good photometry ones. (If you get it, beware of the AUTOPHOT command which is designed for getting statistical results from globular clusters). It operates from a command line where the command and its parameters have to be typed in. This can be a bit tedious, but if you are going through a routine, they can be called up again in turn and modified as required. There are various LOAD commands including one for Starlight Express files.

In subtracting the dark frames, we are attempting to remove all the signal introduced to the image by the CCD. This consists of:-

- 1 *The offset signal - the signal generated by the amplifier and analogue-digital converter, which is independent of the exposure time and CCD temperature.*
- 2 *The thermal signal which is composed of three elements.*
  - a *Mean thermal level - which is proportional to exposure time and related to the CCD temperature.*
  - b *Spatial variation from pixel to pixel of this thermal level.*
  - c *Noise ie. the variation on the thermal level due to the random nature of electrons.*

The common method of subtracting dark frames is to take several with the same exposure as the image during the period of observation, average them, and subtract the result from the image. Unless a large number of dark frames are taken however, there will still be a significant amount of noise in the resultant which will be added to that in the image, and it may be that small variations in CCD temperature will mean that the spatial variation is not matched well also. (Note that in any group of dark frames, doubling the number taken halves the noise).

QMips32 provides a facility called OPT which minimises the noise and produces a more accurate result: eight or more offset frames are first produced using the shortest exposure available (.01 secs), averaged, and this averaged frame is subtracted from each of eight or more dark frames produced with the maximum exposure used for any of the image frames with which it is to be used. The resultant frames are averaged to produce a final dark frame. This will have the noise reduced to a minimum leaving primarily the pixel to pixel variations. Before deducting it from the image frame, this dark frame is compared with the image to find a factor, k, such that when it is multiplied by k and the offset restored, and then subtracted from the image, the spatial noise of the image will be reduced to a minimum. k should be less than 1. This method compensates for differences in both exposure and temperature, and once the dark frame has been generated, it should be good for some time and save generating dark frames during every observing session. There is a DIV command for dividing the image by the flat-field to remove the effect of differences in sensitivity between pixels, and optical effects.

QMips32 then offers three methods of aperture photometry using one, two or three concentric circles. The circle(s) can be positioned on a star with the mouse, but they can also be moved pixel by pixel with the arrow keys. The radii of all three circles can be specified separately. They operate as follows:-

- a *One circle gives the sum of the intensities of the pixels within it.*
- b *Two circles gives the sum of the intensities within the inner circle, less the sky background which is calculated from the area between the inner and outer circles.*
- c *Three circles operate as in (b), but the sky background is calculated from the area between the second and third circles, so that it is less likely to be affected by any fringe light from the star.*

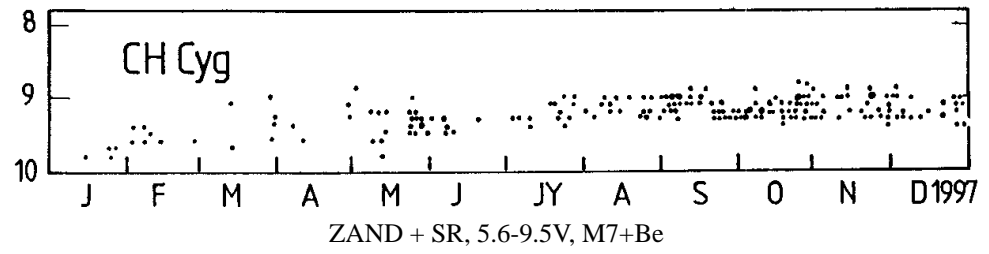
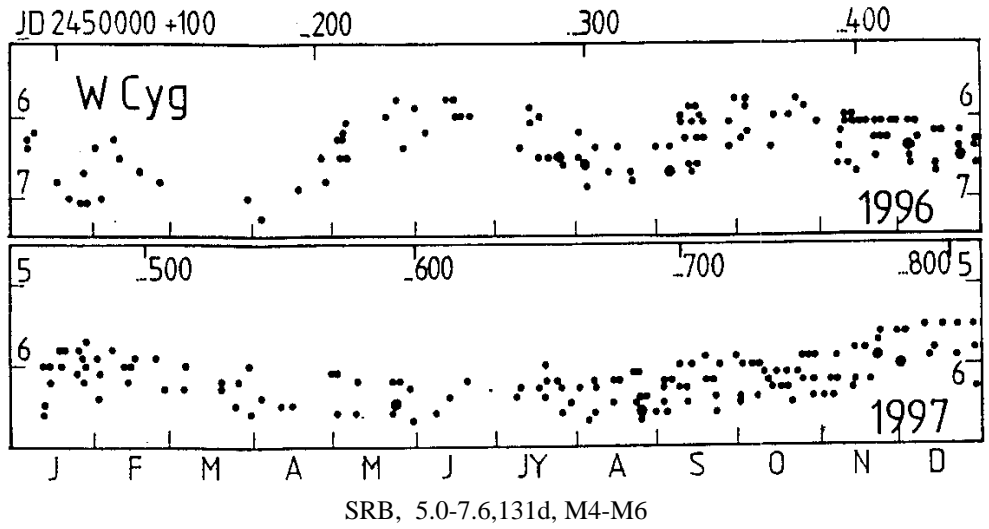
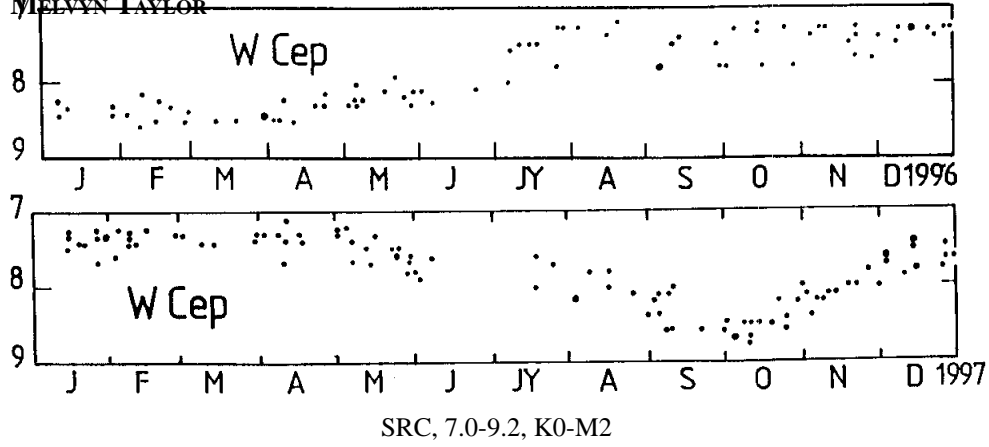
The choice partly depends on how crowded the star field is but also on three other factors which affect the final accuracy:(i) errors in determination of the dark frame and sky background;(ii) photon statistics - to achieve an accuracy of 0.01 mags we need 10,000 photons to struggle through the atmosphere, the telescope, the filter and the CCD, and be detected; as the SXL8 has a conversion rate of about 36 electrons/ADU (Analogue Digital Unit), we would need a total count of not less than 278, so the aperture must not be too small;(iii) linearity - in addition, if the stellar image is bright enough to saturate pixels above the linear limit, then a larger radius is called for so that more pixels within the linear range are utilised. As well as giving the intensities, QMips also returns the result as a magnitude compared to an intensity of '1'.

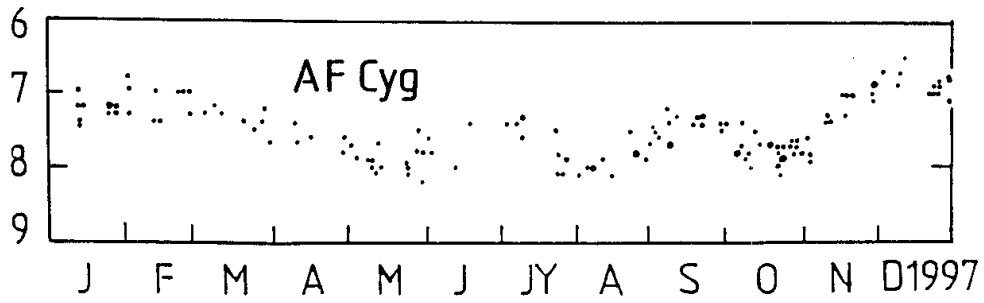
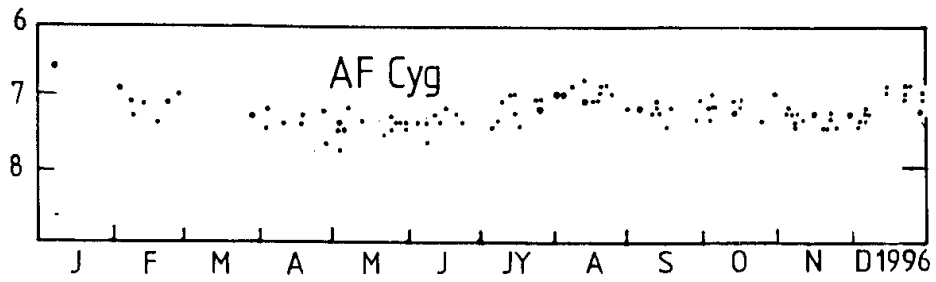
All this can still be a fairly time consuming business. I discovered that MIPS, the original version of QMips32, had a simple programming facility. It is written in a very basic form of BASIC, but enabled me to write a simple suite of programs to import a set of images, preprocess them, specify comparison stars and automate the photometry with fair success. It also produces a table of the results which can easily be read straight into a spreadsheet.

Once the results are on a spreadsheet, the magnitude of the variable can be taken by comparison with the brightest comparison star, the nearest in brightness, or by taking a trend line through all the comparison stars and using that. I feel this may be a further fruitful subject for discussion!

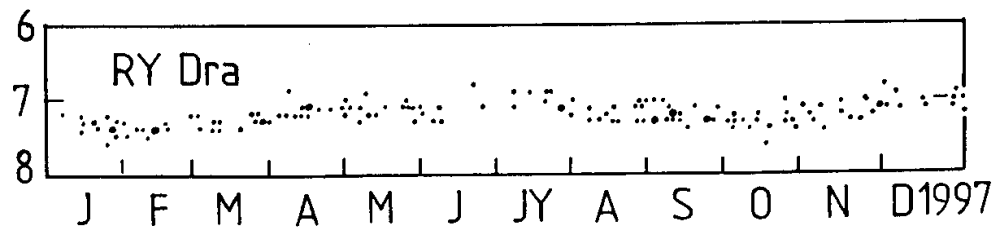
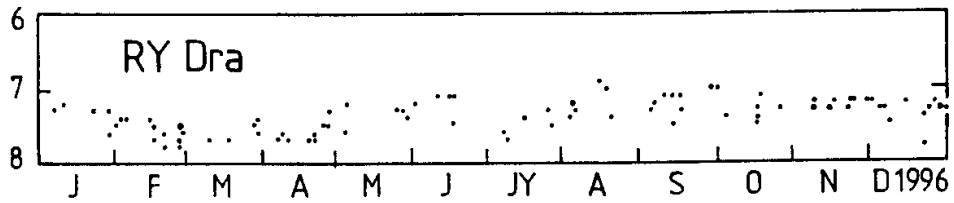
# BINOCULAR PRIORITY STARS - SELECTED LIGHT CURVES

MELVYN TAYLOR





SRB, 6.4-8.4, 92d, M5-M7



SRB? 6-8, 200d?

## ECLIPSING BINARY PREDICTIONS (April - June 1999)

TRISTRAM BRELSTAFF

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

<b>1999 Apr 1 Thu</b>	Z Dra 11(14)16D	RW Gem D08(06)11L	Z Vul 10(15)15D
RW Gem D07(05)10	<b>1999 Apr 12 Mon</b>	U Cep D08(09)14	U Sge 11(17)15D
U Cep D07(10)15	RZ Cas D08(09)12	<b>1999 Apr 22 Thu</b>	RZ Cas 15(17)15D
Z Per D07(12)12L	RW Gem 11(16)12L	Z Dra D08(10)13	<b>1999 May 3 Mon</b>
RZ Cas 13(15)16D	U Sge L11(10)16	U Sge L11(13)16D	TW Dra D09(05)10
Z Per L16(12)16D	<b>1999 Apr 13 Tue</b>	Z Vul 14(19)16D	Z Dra D09(07)09
<b>1999 Apr 2 Fri</b>	TW Dra 08(13)16D	<b>1999 Apr 23 Fri</b>	TX UMa D09(11)15D
TW Dra D08(08)13	RZ Cas 12(14)16D	SW Cyg 15(21)15D	<b>1999 May 4 Tue</b>
ST Per 08(12)11L	Z Per L15(17)16D	<b>1999 Apr 24 Sat</b>	ST Per D09(07)09L
RW Tau 09(14)11L	<b>1999 Apr 14 Wed</b>	TX UMa D08(07)11	Z Dra 13(15)15D
U Sge L12(06)12	Z Dra D08(07)09	RZ Cas D08(08)11	<b>1999 May 5 Wed</b>
TX UMa 15(20)16D	SW Cyg 11(17)16D	S Equ L13(14)15D	RW Gem 09(14)10L
<b>1999 Apr 3 Sat</b>	<b>1999 Apr 15 Thu</b>	TW Dra 14(19)15D	<b>1999 May 6 Thu</b>
Z Dra 08(10)13	RW Gem D08(13)11L	<b>1999 Apr 25 Sun</b>	RZ Cas D09(07)09
<b>1999 Apr 4 Sun</b>	Z Vul L10(10)16	Z Vul L10(06)11	U Cep D09(08)13
Z Per 08(13)11L	Z Dra 13(15)16D	RZ Cas 10(13)15	TX UMa D09(13)15D
Z Per L16(13)16D	U Sge 13(19)16D	<b>1999 Apr 26 Mon</b>	<b>1999 May 7 Fri</b>
<b>1999 Apr 5 Mon</b>	<b>1999 Apr 16 Fri</b>	ST Per D08(08)10L	Z Dra D09(09)11
TW Dra D08(03)08	TW Dra D08(09)14	U Cep D08(08)13	SW Cyg D09(14)15D
RW Tau D08(08)11L	U Cep D08(09)14	Z Dra 10(12)14	Z Vul L09(13)15D
SW Cyg L08(14)16D	RW Tau D08(10)10L	RZ Cas 15(18)15D	RZ Cas 09(12)14
Z Vul L11(15)16D	Z Per L15(19)16D	<b>1999 Apr 27 Tue</b>	Y Psc L15(11)15D
U Sge L12(16)16D	<b>1999 Apr 17 Sat</b>	TX UMa D08(08)13	<b>1999 May 8 Sat</b>
<b>1999 Apr 6 Tue</b>	S Equ L14(17)16D	RW Tau D08(12)09L	RW Gem D09(11)10L
U Cep D08(10)15	<b>1999 Apr 18 Sun</b>	TW Dra 09(14)15D	S Equ L12(08)13
RZ Cas D08(10)12	TX UMa D08(04)08	Z Vul 12(17)15D	RZ Cas 14(16)15D
<b>1999 Apr 7 Wed</b>	Z Dra D08(09)11	<b>1999 Apr 28 Wed</b>	TW Dra 14(20)15D
Z Dra 10(12)14	RZ Cas D08(09)11	SW Cyg D08(11)15D	Z Dra 15(17)15D
Z Per 10(14)11L	ST Per D08(09)10L	1999 Apr 29 Thu	<b>1999 May 9 Sun</b>
RZ Cas 12(15)16D	RW Gem D08(09)11L	U Sge L10(07)13	U Sge L09(11)15D
S Equ L14(09)15	<b>1999 Apr 19 Mon</b>	<b>1999 Apr 30 Fri</b>	TX UMa 09(14)15D
Z Per L16(14)16D	TW Dra D08(04)09	RW Tau D09(06)09L	ST Per L15(14)15D
<b>1999 Apr 10 Sat</b>	RW Tau D08(05)09	RZ Cas D09(08)10	<b>1999 May 11 Tue</b>
SW Cyg D08(04)10	SW Cyg D08(07)13	TW Dra D09(09)14	U Cep D09(07)12
ST Per D08(11)11L	RZ Cas 11(13)16D	TX UMa D09(10)14	RW Gem D09(08)10L
Z Vul L11(13)16D	Z Dra 15(17)16D	Z Dra 11(14)15D	Z Dra D09(10)13
TW Dra 13(18)16D	Z Per L15(20)16D	<b>1999 May 1 Sat</b>	TW Dra 10(15)15D
S Equ 14(20)16D	<b>1999 Apr 20 Tue</b>	U Cep D09(08)13	S Equ 13(18)15D
Z Per L16(16)16D	Z Vul L10(08)14	RZ Cas 10(12)15	<b>1999 May 12 Wed</b>
<b>1999 Apr 11 Sun</b>	<b>1999 Apr 21 Wed</b>	S Equ L13(11)15D	SW Cyg D09(04)10
U Cep D08(09)14	TX UMa D08(05)10	<b>1999 May 2 Sun</b>	Z Vul D09(11)15D

TX UMa 11(16)15D	<b>1999 May 25 Tue</b>	RZ Cas 11(14)14D	Z Vul D10(06)12
U Sge 14(20)15D	RZ Cas D10(10)12	Z Dra 12(14)14D	RZ Cas D10(08)10
<b>1999 May 13 Thu</b>	TW Dra 11(16)14D	Z Per 13(17)14D	TX UMa D10(10)14D
RZ Cas D09(11)14	S Equ L11(12)14D	ST Per L13(17)14D	Z Dra D10(11)13
U Cep 15(19)15D	ST Per L14(11)14D	U Cep 13(18)14D	S Equ D10(13)14D
<b>1999 May 14 Fri</b>	<b>1999 May 26 Wed</b>	<b>1999 Jun 8 Tue</b>	X Tri L13(12)14D
RW Gem D09(04)09L	U Cep D10(07)11	Z Vul D10(11)14D	<b>1999 Jun 19 Sat</b>
TW Dra D09(10)15D	U Sge D10(09)14D	SW Cyg D10(14)14D	RZ Cas D10(12)14D
RZ Cas 13(16)15D	Z Dra D10(09)11	S Equ L10(06)11	X Tri L13(12)14D
<b>1999 May 15 Sat</b>	RZ Cas 12(15)14D	TW Dra 11(17)14D	<b>1999 Jun 20 Sun</b>
Z Dra 10(12)14	Z Per L13(12)14D	<b>1999 Jun 9 Wed</b>	Z Vul 12(17)14D
TX UMa 12(17)15D	<b>1999 May 28 Fri</b>	TX UMa D10(05)10	X Tri L13(11)14
<b>1999 May 16 Sun</b>	TW Dra D10(11)14D	<b>1999 Jun 10 Thu</b>	<b>1999 Jun 21 Mon</b>
U Sge D09(05)11	U Cep 14(18)14D	U Cep D10(05)10	TX UMa D10(11)14D
U Cep D09(07)12	<b>1999 May 29 Sat</b>	Y Psc L13(08)13	Y Psc L12(16)14D
SW Cyg 12(18)15D	Z Vul D10(15)14D	<b>1999 Jun 11 Fri</b>	X Tri L12(10)13
<b>1999 May 17 Mon</b>	U Sge 12(18)14D	TW Dra D10(12)14D	<b>1999 Jun 22 Tue</b>
TW Dra D09(06)11	Z Per L12(13)14D	S Equ 11(16)14D	SW Cyg D10(08)14
Z Vul D09(08)14	<b>1999 May 30 Sun</b>	Z Dra 13(16)14D	U Sge D10(10)14D
ST Per L14(12)14D	Z Dra D10(10)13	<b>1999 Jun 12 Sat</b>	Z Dra D10(12)14D
<b>1999 May 18 Tue</b>	SW Cyg D10(11)14D	U Sge D10(06)12	U Cep 12(17)14D
S Equ L12(15)14D	<b>1999 May 31 Mon</b>	TX UMa D10(07)12	TW Dra 12(17)14D
TX UMa 14(19)14D	U Cep D10(06)11	RZ Cas D10(08)11	<b>1999 Jun 23 Wed</b>
Y Psc L14(18)14D	TW Dra D10(06)11	U Cep 13(17)14D	ST Per L12(14)14D
U Cep 14(19)14D	RZ Cas D10(09)12	<b>1999 Jun 13 Sun</b>	<b>1999 Jun 24 Thu</b>
<b>1999 May 19 Wed</b>	<b>1999 Jun 1 Tue</b>	SW Cyg D10(04)10	TX UMa D10(13)14D
RZ Cas D09(11)13	S Equ L11(09)14D	Z Vul D10(08)14	<b>1999 Jun 25 Fri</b>
U Sge D09(14)14D	RZ Cas 12(14)14D	RZ Cas 11(13)14D	S Equ D10(10)14D
Z Dra 11(14)14D	Z Per L12(15)14D	X Tri 13(16)14D	RZ Cas D10(12)14D
Z Vul 14(19)14D	<b>1999 Jun 2 Wed</b>	<b>1999 Jun 14 Mon</b>	TW Dra D10(13)14D
<b>1999 May 20 Thu</b>	ST Per L13(10)14	TW Dra D10(07)12	Z Vul D10(15)14D
RZ Cas 13(15)14D	U Cep 13(18)14D	Z Dra D10(09)11	Y Psc L12(10)14D
Z Per L13(09)14	<b>1999 Jun 3 Thu</b>	X Tri L13(15)14D	U Sge 13(19)14D
<b>1999 May 21 Fri</b>	Z Dra D10(12)14D	<b>1999 Jun 15 Tue</b>	<b>1999 Jun 26 Sat</b>
U Cep D09(07)12	Z Vul D10(13)14D	TX UMa D10(08)13	Z Dra 12(14)14D
SW Cyg D09(07)13	<b>1999 Jun 4 Fri</b>	U Sge D10(15)14D	<b>1999 Jun 27 Sun</b>
<b>1999 May 22 Sat</b>	Z Per L12(16)14D	ST Per L12(16)14D	TX UMa D10(14)14D
Z Vul D09(06)11	S Equ 14(19)14D	X Tri L13(14)14D	U Cep 12(16)14D
Y Psc L14(13)14D	<b>1999 Jun 5 Sat</b>	<b>1999 Jun 16 Wed</b>	<b>1999 Jun 28 Mon</b>
<b>1999 May 23 Sun</b>	U Cep D10(06)11	X Tri L13(14)14D	TW Dra D10(08)13
Z Per L13(11)14D	U Sge D10(12)14D	<b>1999 Jun 17 Thu</b>	<b>1999 Jun 30 Wed</b>
Z Dra 13(16)14D	<b>1999 Jun 6 Sun</b>	SW Cyg 12(18)14D	Z Vul D10(13)14D
U Cep 14(19)14D	RZ Cas D10(09)11	U Cep 12(17)14D	TX UMa 11(16)14D
<b>1999 May 24 Mon</b>	Y Psc L13(14)14D	X Tri L13(13)14D	Z Dra 13(16)14D
Z Vul 12(17)14D	<b>1999 Jun 7 Mon</b>	<b>1999 Jun 18 Fri</b>	

The deadline for contributions to the 100th issue of VSSC will be May 7th, 1999. 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.

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## TELEPHONE ALERT NUMBERS

**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 01245 475297 (weekdays) 01284 828431 (weekends).

**Variable Star Alerts**

Telephone Gary Poyner (see above for number)

**BAAVSS web pages:**<http://www.telf-ast.demon.co.uk/>

## Charges for Section Publications

The following charges are made for the Circulars. These cover one year (4 issues). Make cheques out to the BAA. Send to the Circulars editor.

	<b>UK</b>	<b>Europe</b>	<b>Rest of World</b>
<b>BAA Members</b>	£3.00	£4.00	£6.50
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