VSS MEETING - PART 1

TRISTRAM BRELSTAFF

For its 1996 meeting on October 5th, the VSS were the guests of the Astronomical Section of the Northamptonshire Natural History Society (NNHS). The meeting was opened by Bob Marriot who welcomed the VSS on behalf of the NNHS and then gave way to Gary Poyner, the Director of the VSS. Gary announced that Dave McAdam had almost reached the million mark in the entry of observations into the VSS Computer Archive. He then introduced **Guy Hurst** who was to speak on **Novae and Supernovae**.

Guy said that his talk would be mainly about searching for novae, with a little bit on supernovae. He summarised the work of George Alcock, the main inspiration for the UK Nova/Supernova Patrol. George had found 5 novae so far but Guy stressed that that was only after thousands of hours of searching. Even at the age of 85, George had still clocked up 300 hours so far this year.

The UK Nova/Supernova Patrol has the following aims:

1) To discover novae and supernovae (for the latter you really need at least a 6-inch telescope)
2) To check out other people's discoveries
3) To carry out follow-up magnitude estimates and astrometry (to 0.1 arcsec accuracy)
4) To monitor stars known to show recurrent outbusts at long intervals
5) To compile lists of stars omitted from atlases (these can give rise to false alerts)
6) To chart selected regions of the sky and the areas around galaxies to make it easier to find novae and supernovae
7) To liaise with the IAU Commission on Supernovae, the Central Bureau for Astronomical Telegrams, and professional astronomers interested in novae and supernovae
8) To publish details of discoveries as soon as possible (mainly by e-mail now)
9) To publish preliminary light-curves and more detailed analyses in The Astronomer, the Journal of the BAA, and other places.

The Patrol was founded in 1976 after several pre-discovery images of novae were found post-discovery on 35mm photographs. The first success for the Patrol was John Hosty's remarkable discovery of Nova Sge 1977. This was followed by Robbie McNaught's discoveries of Nova Cen 1980 and Nova Sgr 1987. Then came Dave McAdam's "Nova" And 1988 which actually turned out to be a WZ Sge type dwarf nova. The first comparable success for the Supernova Patrol came only recently with Pesci's discovery of SN1995al.

Guy outlined the various features of nova light-curves and then went on to describe three particular novae in more detail. Nova Her 1991 was found by George Alcock and confirmed by Denis Buczynski, who photographed it in very strong morning twilight. It faded very rapidly from its maximum of mag 5 and probably no more than 200 magnitude estimates were made of it world-wide.

Nova Sge 1977 (= HS Sge) was found by John Hosty at about mag 7.4 when it was at an altitude of only 10 degrees. Guy has recently re-reduced all available estimates of it using photoelectric magnitudes for the comparison stars and is hoping to publish the results in the Journal of the BAA. This will apparently be the first published light-curve of this nova. It shows a very rapid fade from maximum down to mag 11.5, and then a slower decline.

V705 Cas (= Nova Cas 1993) showed a DQ Her type light-curve: a long drawn-out maximum with superimposed rapid fluctuations, followed by a steep fade into a deep broad minimum, and then a partial recovery to a secondary maximum before the final decline set in. Guy pointed out that in recent observations of the final decline there were large discrepancies between CCD and visual observations and also between visual observers from different countries! The latter were probably due to differences between the comparison stars used. He also pointed out a small dip of about 0.5 mag that preceeded the big minimum. There is a suggestion that there was a similar dip in the light-curve of DQ Her and Guy said that some professional astronomers had shown interest in this feature.

Guy finally said a few words about the types of supernova. He showed a light-curve for SN 1995al and pointed out that on the decline visual observations were consistently about 0.5 mags brighter than photoelectric V-measures.

In the subsequent discussion, Mark Kidger said that the discrepancies in the light-curves were most probably colour effects. Unfiltered CCD photometry is not really much use and even with filters it needed careful calibration. Concerning stars missing from atlases, he added that the Guide Star Catalogue was "hopeless" and had "loads of missing stars". In his work on Tenerife he had known several professional astronomers who had become convinced that they had discovered something, only to find that it was just an omission from the GSC. Guy added that there tends to be lots of such omissions near galaxies - maybe nebulosity upset the algorithms used in the compilation of the GSC?
Gary Poyner said that it was important to keep V705 Cas under observation as long as possible.

This summary of the talks given at the variable star meeting will be continued in the next circular.

VSS MEETING - PART 2

TRISTRAM BRELSTAFF

The next talk was on V-band CCD photometry in which John Mackey described his experiences using a Starlight Xpress CCD for photometry. His first attempt was on Nova Cas 1993 in February 1994 when he derived a magnitude from an unfiltered image. He was unsure of the reliability of this magnitude and so waited to see other people's results before submitting it. As it turned out, his magnitude was 0.8 mag brighter than visual observations made on the same night. He was later told that this was due to the sensitivity of his CCD to the strong infrared emission from that particular nova. This impressed upon him that he really needed to use filters if he was to get useful results.

He now uses a Schott BG39 blue filter to block the red end of the spectrum and a OG515 yellow fiter to block the blue end. This narrows down the response of the CCD to aproximately the V-band. One draw-back of using filters is that they reduce the amount of light reaching the CCD and so increase the required exposure times - typically by a factor of two or three. With these longer exposures you need an accurate drive for the telescope. The above filters only cost a few tens of pounds each and were of reasonable quality for amateur use. For carrying out B and R band photometry as well you would need some mechanism such as a filter wheel for changing filters.

John said that the Guide Star Catalogue magnitudes were not accurate enough for photometry but he had got reasonably consistent results by using four comparison stars for each measure - two brighter and two fainter than the variable.

In CCD photometry it is important to avoid saturating the image. In spite of what is sometimes said, CCDs are not linear over all their range. The best way to check for saturation was to use the CCD software to display a histogram of the image and to check the peak height.

John then outlined various possible observing programs. These included novae, supernovae, active galaxies, variable stars, comets, asteroids and mutual phenomena of satellites.

In the discussion, Mark Kidger pointed out that the Starlight Xpress CCD was well suited for V-band photometry as its sensitivity peaked in the visual, but that most other CCDs peaked in the red and so were better for R-band photometry. In response to a question from Karen Holland, John said that he used the bright twilight sky for flat-fielding. This was at 1/2 to 2/3 saturation.

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VSS MEETING, NORTHAMPTON, 1996 OCTOBER 5TH - CONTINUED

TRISTRAM BRELSTAFF

The last speaker before lunch was John Toone who spoke about Binocular Variables. Thirty years ago binocular observing played only a minor role in British variable star observing but this was changed in the late 1960's by the success of George Alcock in nova searching and by the work of the Binocular Sky Society on bright variable stars. The advantages of binoculars relative to telescopes include their robustness, handiness, low cost, and the fact that the observer uses both eyes. John said that binocular vision was more comfortable than monocular vision .

John went on to the describe a few of the best binocular variable stars and to show charts, photos and light-curves of them. R Sct is situated in the Scutum stars cloud near the cluster M11 and varies from mag 5 to about mag 8 in a deep minimum. Z UMa, in the bowl of 'The Plough' shows occasional double maxima. V CVn, below the tip of the handle of The Plough is the 'Variable Star of the Year' in the BAA Handbook for 1997. R CrB shows occasional unpredictable fades and the detection of these fades is almost entirely down to binocular observers. CH Cyg shows very complicated light variations which involve semiregular pulsations, Z And type outbursts, rapid flickering and eclipses. At maximum it is brighter than mag 6 but at the present it is below mag 10, as faint as it has ever been seen, and it is too faint for binoculars. Finally, John showed a light-curve of the short-period pulsating star SX Phe that he had obtained one night while on holiday in the Canary Islands. This showed very clearly the 80 minute period and the modulation of the magnitude at maximum.

In the discussion, Bob Marriot said that he had recently been to visit the old VSS observer Frank Knight at his home in Epsom. Frank had just donated his observing notebooks to the BAA. These notebooks contained records of observations of R Sct that Frank made from fox-holes at El-Alamein during the war. Melvyn Taylor said that in more recent years, Frank's early morning observations of R Sct in January had been very important in reducing the winter gaps in the light-curve. Bob said that he had found binocular observing a good way of salving his conscience when he couldn't be bothered to open up his observatory.

Shaun Albrighton said that ever since a large number of suspected variables had been dropped from the programme he often found himself running out of stars to observe. He suggested that we should add another 30 to 40 binocular stars to the program. Gary Poyner said that personally he would have an open programme but suggested that this might make things difficult for the Secretary. Guy Hurst said that there were many neglected variables in the mag 9 to 11 range that were within the reach of large binoculars. Mark Kidger suggested that what was needed was some sort of prioritisation. John Toone pointed out that we do actually have a 'Priority List' of stars that should be observed in preference to the others. He added that the main problem with adding stars to the Program was the production of charts.

After lunch the first speaker was Dr Mark Kidger who was to speak on the International OJ287 Project. Mark started off by explaining that when the Canary Isand observatories were established, 5% of the time on them was set aside for collaborative projects that were too large to be carried out by any other means. This 5% is a very significant resource when you consider that it means about 17 nights per year on each of the Canary Island telescopes. This includes the 4.2m William Herschel Telescope, the 2.56m Nordic Telescope, the 2.5m Isaac Newton Telescope and so on. The average professional astronomer would be lucky to get more than one night per year on one of these telescopes. In 1993, it was decided that the active galaxy OJ287 would be a suitable subject for one of these collaborative projects.

Mark then gave a brief introduction to active galaxies and quasars. He described 3C279 which in 1936 had brightened to mag 10.4 and had briefly become the most luminous object in the observable universe. This object shows regular outbursts of 3 to 4 mags. Mark's favorite galaxy is 3C345 which shows 2 to 3 mag eruptions at 3.5 year intervals. However, it is currently at mag 18 and professional astronomers have tended to lose interest in it. Getting back to OJ287, Mark described it as 'The Finnish National Quasar' as you apparently could not qualify as an astronomer in Finland without having observed it. He showed the light-curve from 1891. This showed evidence for large outbursts at intervals of about 11.5 years. Periodicity in astronomical phenomena is often significant as it can indicate the presence of either pulsations or else orbital motion. For OJ287 the latter may well be the case. A model of it has been proposed that consists of a binary system with a 100 million solar mass black hole orbiting a 17 billion solar mass one (the latter is about 1/20th the mass of our Galaxy). The true orbital period of these would be 9 years but, because of the red-shift, this is stretched out to 11.5 years in our observing frame.

The period and amplitude of the outbursts seem to be modulated, maybe on a period of 60 years. This may be due to the orbit precessing very fast. Mark said that not everyone on the project team believed this (out of 40, 3 were convinced, 3 thought it rubbish, and the rest thought it interesting but remained undecided). One problem is that a binary black hole such as this would be unstable and would lose energy very rapidly by emitting gravitational radiation. The orbit would decay and the black holes coalesce in about 1000 years. Calculations showed that there was only about a 1 in 1000 chance that of all the observable quasars one would be in this binary stage at the moment.

The OJ287 project was started in 1993 in order to observe the next major outburst which was predicted for 1994. Observations were made from all round the world and from satellites, as well as from the Canary Islands. Visual observations by amateurs (including the BAA observers Bill Worraker, Gary Poyner, John Toone and Nick Hewitt) were also accepted. A particularly valuable contribution was made by the Canadian amateur Paul Boltwood who made 1200 observations out of the 3000 total using a 7-inch refractor fitted with a CCD.

The prediction was that there would be two outbursts about a year apart. This is actually what was seen. However, observations at various wavelengths raised all sorts of other questions. For example, when it was bright in visual light it was faint in radio waves and in X-rays but a marginal detection with the Compton Gamma-ray Observatory suggested it was bright in gamma-rays. It is difficult to explain how it could simultaneously be bright in gamma-rays and faint in X-rays.

As well as the major flares, the light-curve seems to show almost continual small flares of 0.5 to 1.0 mags with a periodicity of about 35 days (this period also shows up in polarisation data). In addition, in late 1993, Mark obtained evidence for a fade of 0.5 mag in the V-band during one night.

In one model for the OJ287 system it has a relativistic jet similar to that of 3C273 but which is pointing almost directly at us. The flares are shock waves going into the jet which are then magnified by relativistic effects.

In summing up, Mark said that they couldn't have chosen a better subject than OJ287 for their International Project.

- **To be continued in the next circular**

VSS MEETING, NORTHAMPTON, 1996 OCTOBER 5TH

(CONTINUED FROM VSSC 92)

TRISTRAM BRELSTAFF

Kevin West then spoke on Photoelectric Photometry. First he described how he had become dissatisfied with the results he was getting making visual observations through binoculars. He experimented with using a variable artificial star but found it even harder to use than making visual estimates. He then made an equalisation photometer by fixing a camera iris in front of one side of a pair of binoculars. Again this was not very successful. When he heard that Malcom Porter was wanting to sell his Optec SSP3 photometer, Kevin jumped at the chance, even though he didn't yet have a telescope to mount it on. He now has a 20cm Newtonian reflector in a run-off roof observatory. Over the past 3 years he has made 1700 observations, which equates to about 42 hours at the eye-piece. These observations are now in the BAA Computer Archive (the AAVSO would not accept them because he did not use their designated comparison stars).

Kevin explained that his choice of objects to observe was limited by several factors such as the size of his telescope, the type of photometer, the sky brightness at his observing site and the weather. These all restricted the magnitude range for which he could get reasonable counts. He had selected an observing program with the need to get good observational coverage in spite of these circumstances. This meant relatively slowly varying stars at high declinations. This minimises the effects of gaps due to bad weather, and to seasonal invisibility. Kevin had a priority system within his program. Priority 1 were the semiregular variables Mu Cep, HD 116475, UX Dra, Delta^2 Lyr and RR UMi, and the Cepheids Eta Aql, RT Aur, SU Cas and V473 Lyr.

Originally Kevin's observing sequence consisted of making measurements in the order Comparison star - Variable star - Comparison star. However, at the suggestion of Chris Lloyd, he now includes a check star and uses the sequence Comp-Var-Comp-Var-Comp-Check-Comp. This whole sequence takes 10 to 15 minutes.

The biggest source of error is variations in sky transparency. Kevin said that the photometer often detected cloud before he could see them. He also said that he occasionally saw sudden increases in his counts for no apparent reason. Someone had suggested that this might be due to cosmic rays hitting the detector. He went on to say that it is possible to transform the results to the Johnson system and to correct for extinction and for colour differences. However, it is always best to minimise these corrections by chosing comparison stars that are close to the variable and similar in colour.

Kevin then showed some of the light-curves he had obtained. HD 116475, the recently discovered red variable near V CVn, is definitely semiregular and shows a period of about 73d. Observations by the Hungarian Laszlo Kiss agreed to within 0.02 mag with Kevin's results. His light-curve of UX Dra showed clearly the 168d period listed in the GCVS. RR UMi is important in that it is one of the few semiregular variables in a binary system with a well-known orbit (and hence a well-determined mass). Analysis of Kevin's observations by Chris Lloyd showed no evidence for the 43d period listed in the GCVS but did show periods of 34d and 61d. Kevin's observations of VY UMa confirmed the 120d period found by Ofek et al. (JBAA, 105, 33-34, 1995). This period is apparently absent from earlier AAVSO data. Kevin had also, along with Roger Pickard, contributed observations of X Per to a paper by

Paul Roche that was published in the Monthly Notices of the RAS.

For light relief, Kevin started observing Cepheids. He was inspired to do this by seeing visual light-curves published by John Isles. However, he was now producing useful results for these stars too. He was observing RT Aur at the request of Laszlo Kiss who was studying Cepheids for his PhD, and was observing V473 Lyr at the request of Don Fernie in Canada. The latter star varied between mags 6.0 and 6.3 in 1994 but in 1996 its amplitude was below 0.01 mag.

Kevin rounded off by showing a set of observations of Comet Hyakutake that he had made at the suggestion of Jonathan Shanklin to monitor for possible very rapid variations. These were made at rather low altitude and the results were inconclusive, but they were good practice for Comet Halc-Bopp!

Gary Poyner then introduced the next speaker as someone who only a year ago had said he was a visual observer who would never turn to CCDs. **Tonny Vanmunster** then got up to speak on The Center for Backyard Astrophysics.

First of all he outlined the current models for cataclysmic variables (CVs).These are close binary stars in which gas is flowing from a cool component into an accretion disk around a hot component. In the so-called 'intermediate polars' the magnetic field of the hot component is relatively weak and the disk has only a small hole at the centre. This disk is thought to suffer from two kinds of instabilities: thermal instabilities which lead to normal dwarf nova outbursts, and tidal instabilities which lead to SU UMa type superoutbursts. In the 'polars', on the other hand, the magnetic field of the hot component is strong enough to prevent the disc from forming and gas can only approach the hot component via its magnetic poles. Being binary stars, many CVs also show eclipses which allows details of the structure of the system to be determined.

Tonny has been a keen visual observer of CVs for several years. However, he was recently asked by Professor Joe Patterson of Columbia University in the USA if he would be willing to take part in a CCD monitoring of CVs. Joe was running what he called the Center for Backyard Astrophysics (CBA - not to be confused with CBAT). The objectives of CBA were to create an international, multi-longitude telescope network that addresses the entire range of research issues in the photometry of CVs and X-ray binaries.

The CBA grew out of a collaboration in 1984 between Patterson and David Skillman, an amateur who had built an automatic photometric telescope. It now has amateur 'stations' in the USA, Denmark, Belgium, Japan and New Zealand, as well as professional ones in Chile, Israel, Japan and South Africa. This spread in longitude enables them to combine results to get much better coverage of the rapid variations of CVs. The results obtained by the CBA are published in the Publications of the Astronomical Society of the Pacific and in other Journals. These are then used to support applications for funding grants for further work.

Joe Patterson has stated that he thinks that the leadership in variable star research will soon return to amateur astronomers, where it was before 1900. The problem for professional astronomers was that the closure of small observatories and the increasing competition for time on the remaining facilities means that practically all of their observations have to be done in short single-shot observing sessions. Some professionals even suspect that variable star research might enter a dark age.

Tonny then described the set-up he used at his CBA station. He has a 25cm Meade SCT

equipped with an SBIG ST7 CCD in a run-off roof observatory. He does not use filters because the aim of his work is just to detect periodicities. He has automatic pointing (using the GSC) so he doesn't even have to know the constellations! He described how he sets up the telescope at the start of the night and then leaves it to follow the variable round the sky by itself, taking one image every minute. This leaves Tonny free to get on making visual observations of other CVs.

In a single night, the CCD records about 50 megabytes of data which is stored on ZIP drives. At the end of the night, he uses a program written by Patrick Wils to run through the images, identify the variable and comparison stars and produce a preliminary light-curve. This shows if anything interesting has been recorded. He performs more detailed analysis later, at his leisure.

The aim of the work Tonny is involved in is to study the physical properties of CVs through the periodicities they display in their light-curves. These periodicities can be orbital (ie: eclipses), rotational, or superhump periods. Eclipse timings over several decades can be used to show how the orbital periods change. Joe Patterson then has to come up with a physical model to explain these changes. The superhump periods are close to the orbital period determined spectroscopically but are usually slightly longer.

The work of the CBA has revealed new superhump periods in 12 stars including V1159 Ori, RZ LMi and HS Vir. It has also produced a few surprises, for example the discovery that in CN Ori superhumps are present both during superoutbursts and during normal outbursts. In RZ LMi the superhumps are apparently present at minimum, in between superoutbursts. The old nova V603 Aql shows superhump periods that are both longer and shorter than the orbital period at different times. This phenomenon is referred to as 'negative superhumps'. Apparently superhumping is much more widespread amongst CVs than was previously thought.

Tonny went on to outline the future plans of the CBA. They hoped to discover new DQ Her stars (X-ray sources). Joe Patterson suspected that superhumping CVs with orbital periods greater than 3.9 hours should exist, but none had been found so far. They hoped to discover some. They also want to further investigate the negative superhumping phenomenon. Collaboration with spectroscopists should lead to more precise orbital periods. The CBA hoped to have robotic observations at all of its stations. This would allow remote operation but, Tonny pointed out, would require rain detectors. They hoped to set up 2 new CBA stations each year to bring the total up to 10-15.

Summing up, Tonny said that the leadership in variable star research may well pass to amateurs, but only if they work in very close collaboration with professionals.

In answer to a question, Tonny said that the ST7 does have two CCD chips, one for guiding, but the supplied software was no good for guiding while taking serial images. Mark Kidger pointed out that it was OK to use unfiltered CCD photometry for looking for periodicity, but that if you want to demonstrate the existence of something unusual then you must use filters. He added that the CCD equipment that Tonny was using was much better than that which he had been using as a professional only 10 years ago. The gap between professionals and amateurs is closing!

Then **Bill Worraker**, the final speaker of the day, spoke on Eclipsing Dwarf Novae. After giving a brief outline of the cataclysmic binary model for dwarf novae, Bill described the geometry of eclipses in these systems. Observations of the light-curves of the eclipses can

show how the size and structure of the accretion disk changes during an outburst, and so can be used to test the various mechanisms that have been proposed for dwarf nova outbursts. Of these proposed mechanisms, the mass-transfer instability model has now failed several observational tests but the thermal instability model appears to work quite well.

Several techniques can be used to interpret eclipse light-curves. One is just simple visual inspection of its shape. Another is to construct possible models for the system and then compute the eclipse light-curve that they would give. A third method is to start with the observed eclipse light-curve and then try to reconstruct the structure of the system by deconvolution.

Bill went on to describe the results of several observing campaigns he had been involved in. During the superoutburst of HT Cas in November 1995 an eclipse was observed that was 15 mins long and 1 mag deep. A few days later the eclipse was only 8 mins long but 2 mags deep (at minimum the eclipses are only 6 mins long). This suggests that, in this star, the accretion disk is wider early on in the outburst. This in turn suggests that the disk instability associated with the outburst starts at the edge of the disk and moves inwards. This sort of behaviour is referred to an 'outside-in' outburst and the rise in ultraviolet light (which comes from the inner parts of the disk closest to the white dwarf) usually lags behind that in the visual.

By contrast, during the August 1994 and 1996 September outbursts of IP Peg the eclipses were 2.5 mag deep very early in the outburst but were only about 1.5 mag deep the following night and stayed at that depth for the next 10 days. This suggests that early on the light is concentrated at the centre of the disk but quickly spreads out leaving the disk in a quasi-steady state - an 'inside-out' outburst. This has been successfully modelled by researchers at Keele University. In stars such as IP Peg the ultraviolet and visual light rise together.

Bill then showed some eclipse light-curves of the Z Cam star EM Cyg. CCD observations by Nick James and visual observations by Bill himself showed only shallow eclipses (about 0.3 mag deep) at maximum. Visual observations by Gary Poyner suggested they may be slightly deeper at minimum (about 0.5 mag). There is quite a bit of interest in this star because Brian Warner has suggested that it may show eclipses in standstill. However, this has yet to be confirmed as standstills in this star are rather infrequent.

Bill then discussed observations of the September 1996 outburst of the recently discovered dwarf nova HS1804+6753. CCD photometry by Nick James showed that eclipses 1.6 mags deep in quiescence but 3 mags deep in outburst. This is apparently the first dwarf nova found in which the eclipses are deeper in outburst. Bill said that Tom Marsh (Southampton University) had been planning to use the Hubble Space Telescope to observe this star at about the same time.

In the future, Bill said, we needed to get better coverage of IP Peg, HT Cas and, if possible, DV UMa. In addition, we needed intensive coverage of HS1804+6753 and S10932. There was also the discovery of new eclipsing dwarf novae. The possibility that there are still quite a lot of these remaining to be discovered is suggested by the small proportion of the known dwarf novae that show eclipses. At less than 3% this is much less than the 20% that would be predicted from simple geometric arguments. This deficit could be caused by a selection effect arising from the disks in eclipsing systems being more edge-on than in non-eclipsing systems. This would mean that the changes in disk luminosity that produce outbursts are less noticable in eclipsing systems and so the observed outburst amplitudes are smaller. Continuous runs of observations of poorly observed dwarf novae at minimum light might well reveal new eclipses or other periodicities.

Gary Poyner said that he had heard that Tom Marsh was upset when HS1804+6753 went into outburst because it made it too bright for the HST to observe. He then thanked Bob Marriot and the NNHS for organising the meeting and all the speakers for their excellent talks. He then closed the meeting.