British Astronomical Association

VARIABLE STAR SECTION CIRCULAR

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

003·03 20′ FIELD INVERTED

SS AURIGAE 06h 13m 22·4s +47°44′26″ (2000)

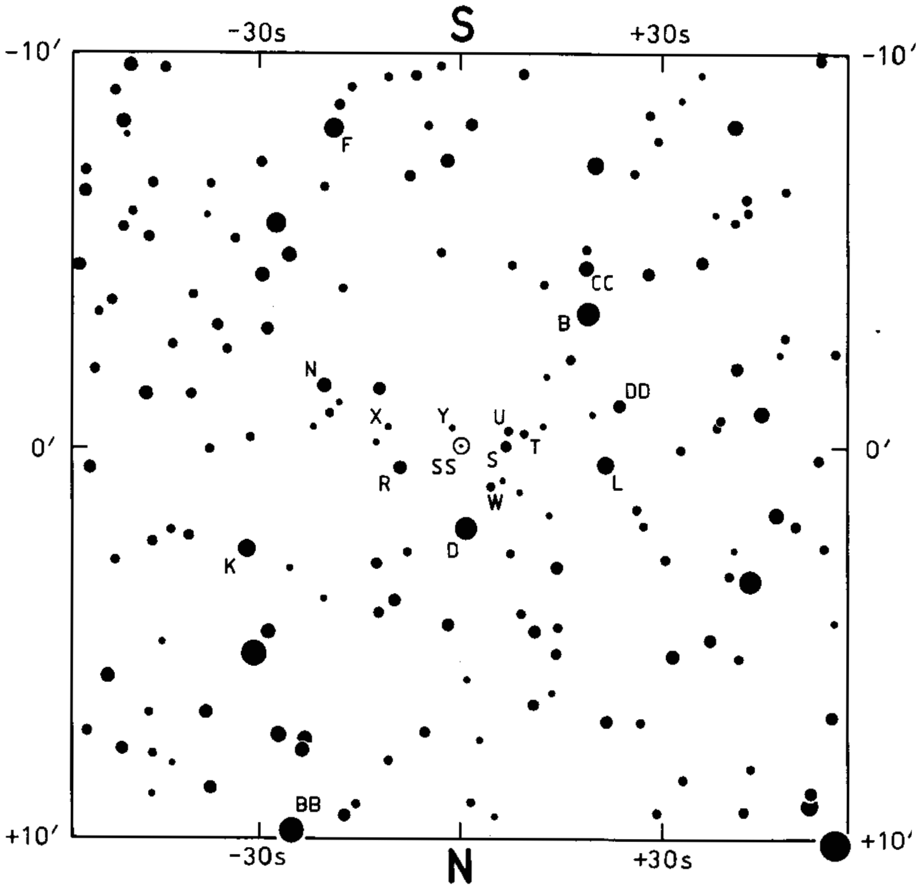


CHART:
STAMFORD PHOTO

SEQUENCE:
BB TYCHO 2 VJ,
OTHERS A.HENDEN

BB	10·5	R	13·9
B	10·9	DD	14·1
D	11·0	S	14·6
F	11·2	T	15·2
K	12·1	U	15·3
L	12·5	W	15·6
N	13·1	X	15·9
CC	13·3	Y	16·3

BAA VSS
EPOCH: 2000
DRAWN: JT 30-03-03
APPROVED: RDP

NEW CHART

JOHN TOONE

FROM THE DIRECTOR

ROGER PICKARD

A New Director for the AAVSO

At the end of January 2005, the AAVSO announced that Dr Arne Henden will be their new Director with effect from March 1st. Dr Henden, or Arne, as he is known to most, will be known to many amateurs around the world for his support and encouragement, especially in the area of photometry and Pro-Am co-operation. He is an *email junkie* (his own words) and will often advise (and correct where necessary!) on anything to do with variable stars (although most likely CVs), on a number of email discussion lists. His primary research interests are in optical and near infrared imaging, variable stars, gamma-ray burst afterglows and professional-amateur collaboration. He also co-authored (with Dr. R. H. Kaitchuck) the textbook Astronomical Photometry, widely regarded as a fundamental text for learning photometry. Further information can be found at *www.aavso.org*. We offer a warm welcome to Arne Henden in his new role, and look forward to closer co-operation with the AAVSO over the coming years.

Negative CCD Observations

Recently, the problem of what to do with negative CCD observations, i.e. stars that are at, or even below the detection limit, arose from an email discussion with Jeremy Shears. Not infrequently, I will look at a star to see if it is in outburst or whatever, but it will be too faint to make a meaningful measurement. In such cases, I will record the faintest star visible, but then there is the problem of labelling it. If Arne Henden (yes, the same one who is to become the AAVSO Director) has produced a sequence for it, then I will look for the faintest star visible, and quote the full magnitude to three decimal places, and use that as my identifier. (This is possibly not perfect, but I feel the likelihood of two stars being measured to the same thousandth of a magnitude is quite unlikely). An alternative is to obtain the USNO A2.0 or B1.0 catalogues (they can be downloaded from the internet in small areas and hence small files), and quote the appropriate number. This can then be sent to John Saxton as a CCD or CCD(V) estimate, depending on whether a filter has been used. In summary, anything which has been measured photometrically, and against which an error can be reported, should go to Andy Wilson. Anything estimated from a CCD frame by *eye* or a *less than* estimate, should go to John Saxton.

Data Input - Old Observations

Following a letter by Alex Menarry and myself in the JBAA last year there was a flood of activity from people wishing to help. Sadly, that initial flood has not been maintained, and although a number of helpers are still doing just that, we need more to help clear the final drawer of old observations - hopefully by the end of this year. Please drop me a line either by email or letter if you think you can spare an odd hour every now and again to help type up some of these observations.

PROJECT QUIXOTE - A VARIABLE STAR SECTION ON-LINE DATABASE - UPDATE

ROGER DYMOCK

This project was outlined in the June 2004 edition of this newsletter, and described in more detail at the section meeting held at Alston Hall in October 2004. The complete presentation made at that meeting can be accessed via the *Table of contents* page on the project website at **http://quixote.astro.ex.ac.uk/**

As previously mentioned, the next steps were to:

- Relocate the database to an ISP who could provide the required storage capacity with the ability to upload large amounts of data
- Upload said (verified) data
- Implement enhancements eg; links to star charts, BAA Journal articles, images and other databases
- Allow direct data input by observers

At the VSS/IIS meeting in Northampton, I was put in touch with Tim Naylor of Exeter University who offered to host the database. With considerable help from John Rowe (Exeter University) the database was transferred to that location, and is now operational.

Following the Alston Hall meeting, several changes were made to the way data is selected and displayed. Upload procedures were successfully pilot-tested 4Q/2004, and data-upload will continue through the early part of 2005.

A brief description of the database, as seen by the user, follows. After logging in (access is controlled by the Section Director, Roger Pickard), the user is presented with the screen (shown in Figure 1 opposite) from which he can choose the star, time period of interest, observer and required data to be output. In this example Chi Cyg has been selected for the time period 1995/01/01 to 2000/01/01, including observations from all observers (observations made by a single observer can also be selected).

Clicking on the *Observations and Light curve* button produces a list of observations, as shown in figure 2, and clicking on the *Light curve* button at the bottom of the page generates the associated light curve.

Thanks are due to:

- Dominic Ford and Nick Hewitt for their guidance in the early days of the project
- Tim Naylor (Exeter University) for agreeing to host the database
- John Rowe (Exeter University) and Callum Potter for their technical support
- Roger Pickard for allowing the VSS to be used for the pilot project
- John Saxton for providing verified data
- All those people who freely contribute to the various websites which I trawled for answers to the many problems encountered while writing the software and generating thedatabase tables.

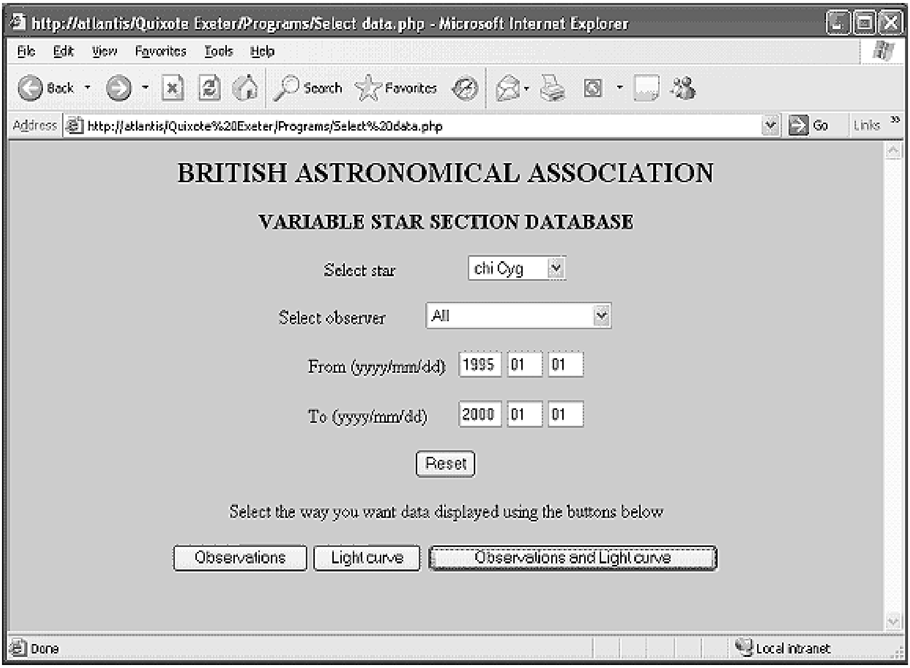
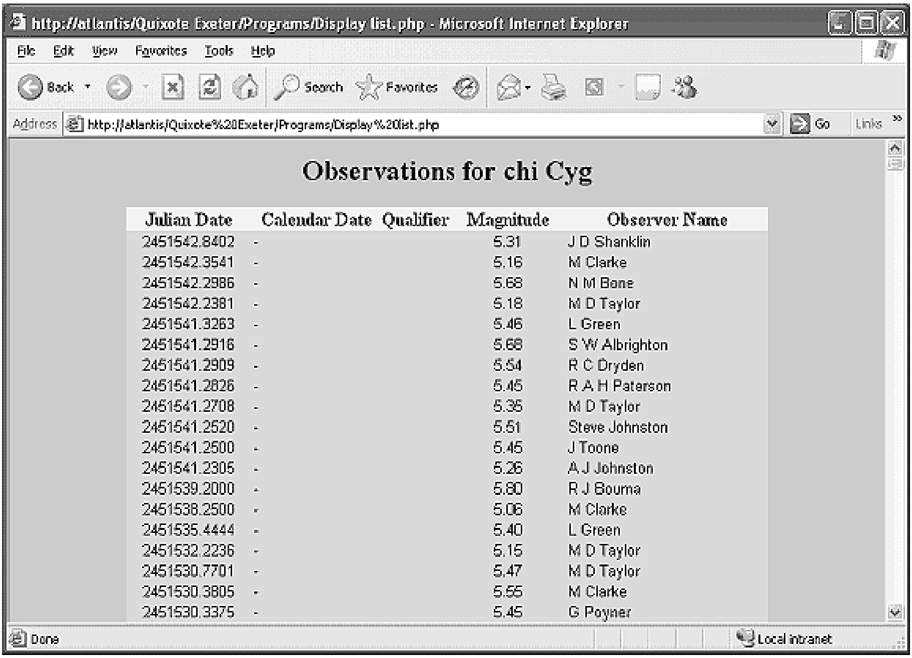


Figure 1, The Introductory Screen

Figure 2, Display of Requested Observations



Julian Date	Calendar Date	Qualifier	Magnitude	Observer Name
2451542.8402	-		5.31	J D Shanklin
2451542.3541	-		5.16	M Clarke
2451542.2986	-		5.68	N M Bone
2451542.2381	-		5.18	M D Taylor
2451541.3263	-		5.46	L Green
2451541.2916	-		5.68	S W Albrighton
2451541.2909	-		5.54	R C Dryden
2451541.2826	-		5.45	R A H Paterson
2451541.2708	-		5.36	M D Taylor
2451541.2520	-		5.51	Steve Johnston
2451541.2500	-		5.45	J Toone
2451541.2305	-		5.26	A J Johnston
2451539.2000	-		5.80	R J Bouma
2451538.2500	-		5.06	M Clarke
2451535.4444	-		5.40	L Green
2451532.2236	-		5.15	M D Taylor
2451530.7701	-		5.47	M D Taylor
2451530.3805	-		5.55	M Clarke
2451530.3375	-		5.45	G Poyner

RECURRENT OBJECTS PROGRAMME - UPDATE

GARY POYNER

Three new stars were added to the ROP on January 19th, and one star has been removed. The three new objects are as follows:

NSV 18241 (PG 0935+075) RA 09h 28' 37" +07 14 55

This star has been seen in outburst on just two previous occasions on November 27.465 UT 1973 at B=13.03, and more recently by Patrick Schmeer on March 28.839UT 2004 at visual magnitude 12.9. Schmeer also notes that the orbital period of NSV 18241 is 0.1868 days (Thorstensen, J.R., Taylor, C.J., MNRAS 326, 1235-1242, 2001) [1]. Tonny Vanmunster obtained one single night of CCD photometry during the 2004 outburst, but failed to record any UGSU signature [2]. This remains the only CCD photometry available at this time, so it would be unwise to draw any conclusions from it. Further monitoring for future outbursts is obviously required.

IR Com 12h 39' 32" +21 08 06.5

IR Com is a deeply eclipsing star below the period gap. Observations over a 20 year period 1985-2005 have revealed just one superoutburst. However, that was in 1985, and the last reported outburst of any nature in this star occured in March 2001. IR Com is thought to be very similar in nature to HT Cas, another eclipsing UGSU star.

Further information can be found in the PASJ publication *IR Com: Deeply Eclipsing Dwarf Nova Below the Period Gap - A twin of HT Cas?* by Taichi Kato, Hajime Baba, Daisaku Nogami. The paper can be downloaded from: **http://arxiv.org/PS_cache/astro-ph/pdf/0110/0110206.pdf**

AY Lac: 22h 22' 23" +50 23 9

This star was thought to be either a Mira, UG or Nova upon its original discovery by Hoffmeister in 1928; this object is now thought to be either a Recurrent Nova or a rare UGWZ type star. It has only been seen in *outburst* on two occasions, in 1928 by Hoffmeister, and in 1962 by Geßner. AY Lac should be considered as a priority ROP star. Further information on AY Lac can be see in IBVS 5441:**http://www.konkoly.hu/cgi-bin/IBVS?5441**

AAVSO charts with Henden/Sumner sequences are available for IR Com and AY Lac. It is hopeful that a chart and sequence will become available for NSV 18241 very soon. Once available, details will be posted on baavss-alert!

The star dropped from the ROP is the Intermediate Polar DO Dra. Eight observations have been recorded since 1994, with the most recent occuring in 2004. In-depth CCD photometry has been carried out during the past couple of outbursts, and whilst interesting information is still being obtained from this object at quiescence and in outburst, it’s *high priority* alert status has been somewhat reduced.

References:

1: P. Schmeer - VSNET posting
2: T. Vanmunster - private communication

VSS DATABASE INPUT SOFTWARE TO BE AVAILABLE VIA VSS WEB PAGES

JOHN SAXTON

Earlier this year I made an appeal for observers to pre-process their data before submitting it to the database. To those of you who have been doing this, I am very grateful. I appreciate that others of you tried, but couldn't get the system to work (or the software package was so large that my hotmail account objected!).

I've now made major revisions to the software to make it easier to use, but also more sensitive to problems in the input data. This was demonstrated at Alston Hall, where it prompted some very useful discussion. It has been improved since Alston Hall, and it will be also be available via the VSS web pages. I have also written some documentation and instructions for it. So keep an eye on the web pages!

BINOCULAR PRIORITY LIST

MELVYN TAYLOR

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

FRANK BATESON AND THE RASNZ MEETING AT TAURANGA IN 2004

JOHN TOONE

The Variable Star Section of the Royal Astronomical Society of New Zealand (VSS RASNZ) was founded by Frank Bateson in 1927, and it very quickly developed into the most dominant variable star organisation in the southern hemisphere. Within its ranks, Albert Jones rose to become the most prodigious variable star observer in history, with an estimated 500,000+ visual observations. Frank Bateson and Albert Jones were amongst the first six observers worldwide to make 100,000 observations of variable stars. The VSS RASNZ was launched and set up on the BAAVSS model, and the two organisations have, for many years, interacted by exchanging data for common stars on their respective observing programmes. Throughout the whole history of the VSS RASNZ, Frank Bateson has been the Director, until he decided to retire at the end of 2004 after an incredible 80 years of being involved in astronomy. To mark this occasion, the RASNZ hosted a major meeting on the 4th December 2004 at Tauranga, which is Frank Bateson's hometown on the North Island. It was my privilege to attend and speak at this meeting.

When travelling to the opposite part of the world for a 30-minute presentation at a single day conference, you need to work on other activities enroute. In this instance, I decided to stop off in Australia for a short holiday in northern Queensland at the suggestion of Peter Williams. My girlfriend, Irene, was particularly smitten with a photo of Four Mile Beach at Port Douglas that Peter had e-mailed me in October 2004. Just before we left, I had the idea of presenting to Frank a picture frame of his first observation of Mira for the BAAVSS back in 1926. Just prior to departing England, I copied the relevant part of BAA Memoir XXXI, and unearthed from my chart archives the 1910 blueprint chart of Mira, drawn by the former VSS Director C L Brook. Upon arrival at Port Douglas, I managed to find two separate shops that would scan, format and suitably frame the observation and chart. The time in Port Douglas was very relaxing with hot weather and stunning tropical scenery. The consumption of fresh exotic seafood, and snorkeling on the Great Barrier Reef, were amongst the highlights of our time there. At night-time I went down onto Four Mile Beach to observe, and I quickly learned that a few things had changed in the southern sky since my last visit *Down Under*. Back in 1999, I was surprised to find **L2 Pup** at magnitude 6.6, when its catalogued minimum was 6.0. Well five years later on it had faded even further to magnitude 7.3. I have been observing **Pi 1 Gru** occasionally since 1981, and only rarely have I seen it within its catalogued range of 5.8 - 6.4. This time it was magnitude 7.0. **R Scl** (magnitude 7.3) and **T Ind** (magnitude 6.6) have also been observed intermittently since 1981, and were both brighter than previously recorded. **RY Sgr** was below maximum at magnitude 8.1, and was immersed in zodiacal light that stretched right up into Aquarius. Large fruit bats were also silhouetted flying against this eerie but pleasing light. Whilst watching Orion rise horizontally over the Coral Sea, I contemplated that you don't experience these kinds of scenes in rural Shropshire.

From Port Douglas we flew down to Sydney where the weather was hot (37C), breezy and cloudy. Our first attempt at landing at Sydney Airport was aborted just short of the runway because a sudden gust of wind blew the aircraft sideways. There was no panic amongst the passengers, which demonstrates how routine flying has become in the 21st

Century. We had one night in Sydney where we were joined by Peter and Linda Williams for a meal by the Harbour. Peter had just completed 100,000 observations the week before (**RY Dor** was the actual observation on November 26th), and he was the second Australian to reach this milestone after Rod Stubbings. Peter told me that it felt like it had been a long time since he had made his first observation of a variable star; this was of **Theta Aps** on 2nd February 1971 (see article on page 17 of this circular). Whilst discussing **L2 Pup**, Peter mentioned that he had seen it below magnitude 8 recently, which meant that my observation at magnitude 7.3 was by no means extraordinary.

We then flew on to New Zealand, which felt much cooler than Australia. In fact the weather on the North Island was more akin to springtime in England, with heavy showers, brisk winds and the odd sunny spell. We drove from Auckland to Tauranga on the Bay of Plenty where the RASNZ meeting was to be held. The day before the meeting we explored Tauranga, and located and surveyed the meeting venue at the Windermere Centre. The evening prior to the meeting, some of the delegates gathered for dinner at a local motel, and this was my first opportunity to meet the RASNZ people. The first person I recognized was Elizabeth Waagen, who was representing the AAVSO as Interim Director, and I soon found myself in conversation with Brian Warner (Head of Astronomy Department, University of Cape Town), Brian Loader (President of the RASNZ), and Albert Jones (legendary variable star observer). It was a great way to get to know everyone prior to the meeting getting underway.

The International Speakers (John Toone, Elizabeth Waggen and Brian Warner)

Saturday 4th December 2004 dawned overcast, cool and dry. Irene went shopping in Hamilton, whilst I attended the RASNZ meeting. I met Frank Bateson for the first time just prior to the meeting commencing. Frank had celebrated his 95th birthday just a month beforehand, and was a little infirm with failing eyesight. Understandably Frank took a break from the meeting during the early afternoon session.

The Mayor of Tauranga opened the meeting, and the morning session was devoted to the international speakers, of which Brian Warner was the first. Brian is the world's leading authority on cataclysmic variable stars, and he eloquently explained their outburst mechanisms, and emphasised the important contributions that amateur astronomers have made to the ongoing research into these exotic stars. Brian pointed out that all of the brightest novae of the past Century, and most recent supernovae in external galaxies were discovered by amateur astronomers, and the earlier they are detected and announced the sooner scientific research can begin.

Elizabeth Waagen then spoke about the long relationship between the AAVSO and the VSS RASNZ. Elizabeth displayed several letters from Frank Bateson which were recovered from the AAVSO archives, including one dating from 1927 that requested charts as he was planning to start up a Variable Star Section within the New Zealand Astronomical Society (abbreviated to VSS NZAS at that time). It was interesting to see within these letters that it was Frank's clear intention to finally report all the data produced by the VSS NZAS to the BAA.

I concluded the morning session by summarising the work of the International Chart Working Group. At the end of this presentation I displayed the following list of the first observers to make 100,000 observations of variable stars:

Charles Butterworth	1939
Frank Bateson	1950
Reginald DeKock	1958
Cyrus Fernald	1960
Leslie Peltier	1962
Albert Jones	1963

The above information was not widespread knowledge at the time, and I remarked that it was a thrill to be at a meeting where the only two surviving members of this select group of observers were present.

Just prior to lunch, and also fortunately before the onset of heavy rainfall, all the delegates gathered for the conference group photograph that is reproduced opposite.

The afternoon session was devoted to New Zealand speakers, of which the first two concentrated upon the development of the Mount John Observatory on the South Island. Alan Gilmore talked about the site testing led by Frank Bateson in the early 1960's at Black Birch, Mount John and Manoburn Dam. Frank wrote a comprehensive report to the Universities of Canterbury and Pennsylvania, and recommended the Mount John site on scientific grounds for the establishment of an observatory. John Hearnshaw then described the history of Mount John Observatory, including the initial period when Frank Bateson was Astronomer-in-Charge. Grant Christie followed this by outlining the history of the work at Auckland Observatory that was established in 1967. This

The RASNZ group

observatory focused on variable stars, initially using visual techniques, then using PEP in 1969 and finally moving to CCDs on the Nustrini Automatic Telescope from 2000. Karen Pollard gave an overview on the RV Tauri class of pulsating variables and her research into them. It was interesting to hear how, as a student, she approached Frank Bateson for amateur data on these variables, and how it was subsequently analysed. Despite the efforts of Karen and others, these variables are still poorly understood. Ranald McIntosh then talked about how he started to digitise the VSS RASNZ records back in 1987 following a request from Frank Bateson. The final speaker of the afternoon session was Albert Jones, who gave an entertaining talk on how chart-draughting and recording and submitting observations had changed since 1942. Albert's description of his first trials with a computer was related to by most of the audience. There was a touching moment when Albert congratulated Frank on his retirement and Frank rose completely unassisted to warmly shake his hand.

The evening session began with a series of tributes and congratulatory messages to Frank Bateson including one from Patrick Moore read out by Brian Loader. Within this session I read out the following messages from Tom Boles and Roger Pickard on behalf of the BAA:

Dear Frank,

On behalf of the British Astronomical Association and all of our observing members who cannot be with you today, I would like to thank you for the major contribution that you have made to astronomy. Had this been restricted merely to New Zealand this would have been a significant achievement in itself, but your influence has spread and affected variable star astronomy worldwide. From everyone here in the UK - all of our variable star observers and so many of our observers in other fields who are aware of your work - I would like to wish you a long and happy retirement. You can be justifiably proud of what you have achieved.

Tom Boles - President, British Astronomical Association

Dear Frank,

I am delighted that John Toone can personally deliver this message as well as that from the BAA President Tom Boles. When I first became interested in variable stars over thirty years ago, it was not long before I heard of Frank Bateson of the RASNZ, and I soon discovered that he was one of the great names in the history of variable stars. However, it was not until I became Director of the BAA VSS only 5 years ago that I first corresponded with Frank, and by then he was approaching 90! I can't help feeling I've missed a great opportunity to learn something. Frank, not only have you been contributing to New Zealand and international astronomy for 80 years, but in that time you have also managed the remarkable total of over 100,000 visual variable star observations, a feat achieved only by a small handful of dedicated observers. You are an inspiration to us all, and yours will be a hard act to follow. You well deserve the recognitions and awards you've received from around the world for your services to astronomy. Congratulations on a most distinguished career.

Roger Pickard - Director, British Astronomical Association Variable Star Section

After reading out the above messages, I presented to Frank the picture frame containing his first observation for the BAA VSS, which was of Mira at magnitude 3.7 on 2nd January 1926 when he was aged just 16 (see picture opposite).

In the evening Frank Bateson himself delivered the after-dinner address entitled *Making the political system work*. Frank reminisced about his interaction with politics throughout his long career. The first was as a schoolboy when he wrote a letter to the Prime Minister complaining about leek soup always being served up for school dinners. The Prime Minister W F Massey actually replied by saying *there will be much in life that you will dislike so eat up and shut up*. However, leek soup did figure less frequently on the school menu thereafter. During the Second World War Frank served in the Navy, and was involved in salvaging gold from the RMS Niagara that went down after striking a mine. The gold had to be recovered as it was destined for Fort Knox, as payment for replacement munitions to the British Army following the Dunkirk evacuation. The first bullion to be recovered was, amazingly, a three-penny bit. Frank was also involved in arresting the skipper of a minesweeper who had gone berserk, armed with a revolver. Frank then touched on the post war years that he spent in the Cook

The Presentation of the Picture to Frank

Islands where he took up the position of trading manager for the Island of Rarotonga. Whilst there, he set up an 8 inch refractor and expanded the VSS NZAS to become the centre for all observations of southern variable stars. However, it was certainly not all astronomy, as on one occasion he had to deal with the expulsion from the island of some renegade Europeans. At the end of 1960 Frank returned to New Zealand to undertake the site testing for what was to eventually become the Mt John Observatory. During this time (height of the cold war) some of the local press suspected that Frank might be a CIA agent, because of his apparently mysterious activities on remote mountaintops. At the end of the site testing, one newspaper, inaptly named *Truth*, published a photo of Frank, surrounded by all the details of the Profumo Scandal. Following each event description, Frank repeated: *I was learning how the political system worked.* In summing up, Frank stated: *By profession I am an accountant, by accident a businessman, but by nature an astronomer. I think I became a politician by saying 'yes' when I should have said 'no'.* It was an eloquent delivery by a distinguished astronomer and variable star observer.

Following the address Frank thanked me for being there, and gave me a signed copy of his book *Paradise Beckons* before retiring. I was left with the thought that outstanding amateur astronomers fall into one of two categories: 1) outstanding observers, or 2) outstanding leaders and organisers. I think that in variable star lore, Frank Bateson was unique, because he achieved it outright in both categories. It was an honour for me to be with him at the formal end of his career, and I do not expect to see anyone else reaching comparable levels of achievement in the foreseeable future of variable star astronomy.

FIRST STEPS IN CCD PHOTOMETRY

JEREMY SHEARS

Introduction

The aim of this article is to relate some of my initial experiments in CCD photometry, in the hope that other people may be encouraged to try. Previously, I had some experience of CCD imaging of deep sky objects for pleasure, but I wanted to achieve some more scientifically useful results from my work. Having attended the Pro-Am symposium on CCD photometry at Northampton in 2004 May, I was stimulated to investigate variable star photometry. I had tried visual variable star observing many years ago, but struggled with locating the objects, and my enthusiasm waned.

The Observatory

I have recently returned to the UK after living overseas for 12 years in various countries. This provided the opportunity to realise my childhood dream of setting up a permanent observatory. The first thing to do, was to work out where to buy a house. The estate agents thought my requirements were slightly unusual. They could understand my wanting to live not too far from work, schools and other amenities, but they thought it a little odd when I added minimal light pollution to the list. However, I backed this up with light pollution maps downloaded from the web, which showed I was serious, and enabled us to identify a *triangle of opportunity* of semi-rural skies in south Cheshire, where we eventually found a house in the village of Bunbury. Since the property was still under construction, I asked the developer to lay a concrete pad, as part of the garden landscaping, ready to accept a 7 ft (2.1 m) dome which was ordered from Pulsar Optical in Cambridgeshire. In the meantime, I applied for planning permission from the local authority; because Bunbury is a conservation area, all construction, even small sheds, needs formal approval. Fortunately, the project was approved, so my prospective neighbours obviously did not raise any significant objections (and have subsequently shown quite a bit of interest in my nocturnal activities).

Figure 1. The Bunbury Observatory, Cheshire

The main telescope is a Takahashi FS102, a 102 mm apochromatic fluorite refractor with a focal length of 820 mm. This is mounted on a Vixen Great Polaris DX, controlled by a Skysensor 2000 GOTO unit, and the whole lot is supported by a very solid pillar from BCF Astroengineering. The CCD camera is a Starlight Xpress MX716. The set up can be seen in Figure 1

First Attempts at Photometry

First light was in early June 2004, and in August I began to experiment with photometry of variables, having purchased the AIP4WINsoftware at the BAA Exhibition meeting at Cambridge. Roger Pickard guided me through the photometry options in AIP4WIN. The first few stars I measured were from the *VSS Basic CCD photometry target list*, using unfiltered photometry. The main problem was that these stars were a little faint for my system, being at quiescence. For example, I was regularly recording **V1363 Cyg** (range 13.0p to 16.7V) below magnitude 16C, but this was too faint for reliable photometry. I have yet to spot **V1454 Cyg** (range 13.9-20.5V) and **V650 Ori** (15.5-19.2V), although I can see a magnitude 16.7 star near the position of the latter.

To keep my interest going, I added a few other brighter stars to my programme, including **Mis1147 Cep**, **TZ Per**, **GK Per** and the AGN, **3C66A And** (a time series on the latter on 2004 Dec 26, 17.37 to 22.53UT, suggested an irregular variation of about 0.1 magnitudes, but the amount of scatter in the data means that no definite conclusion can be drawn; this is one to follow up on in the future).

Having almost sorted out the basics, I realised I should really be doing routine photometry using a proper filter. At the VSS meeting in Preston, I purchased a V-filter from Norman Walker. I have made some observations with this, but the loss of up to 2 magnitudes is a little disappointing. Clearly I will need to adapt my observing programme to include some brighter stars, and suggestions of suitable targets are always welcome. In an attempt to extend my magnitude limit, I carried out some experiments with a C8 f/6.3, in place of the Tak FS102. Using my typical exposure time of 60 s, I found that the ADU counts for a range of stars were, on average only 1.85 times higher with the C8. This implies that the photometric light gathering power of the C8 is about equivalent to a 136 mm refractor. Given the Tak FS102 is lighter and the focal length is shorter than the C8, both contributing to better tracking accuracy, I have decided to optimise my technique with the refractor for the time being.

Photometry of Supernovae

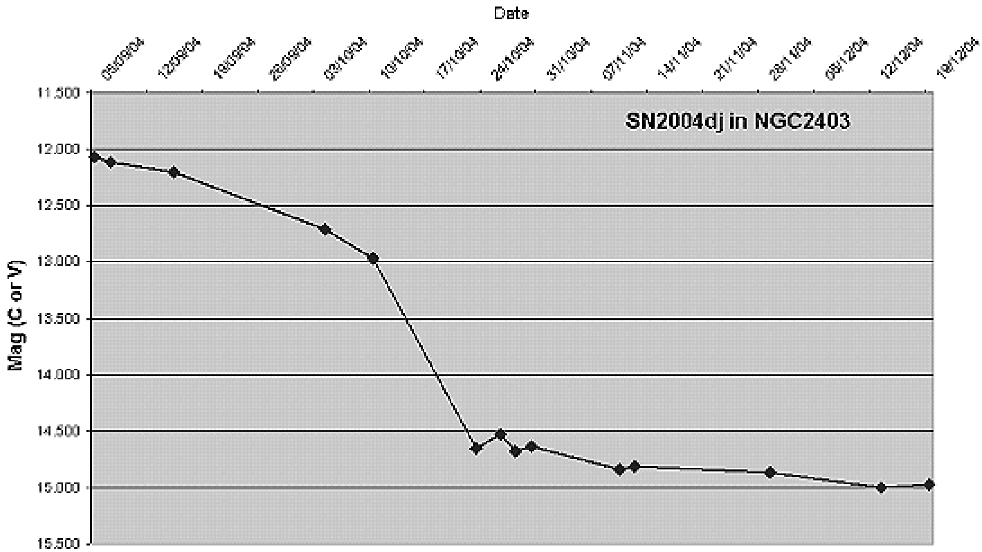
During 2004 there were two particularly bright SNe: **SN2004dj** in NGC2403 and **SN2004et** in NGC6946. Both galaxies are great targets for CCD imagers, and that was my starting point (Fig 2). Later I began to perform photometry on the images, which were submitted regularly to Guy Hurst, and combined with many other people's observations to build an overall light curve of these SNe. However, for my own pleasure I have produced my own light curves and that for SN2004dj is shown in Fig 3.

Photometry of Cataclysmic Variables

One area that I wanted to have a go at is time series photometry on CVs, especially with the aim of detecting superhumps in possible UGSU stars. I guess I wanted to have a go at a target that *did something*. My first attempt was with **Var79 Peg** on 2004 Oct 30, but I used the V-filter, and the reduced sensitivity resulted in appreciable scatter (around magnitude 14.7V). I also worked on **Var80 Per** on 2004 Nov 13; I suspected some variation, but again there was too much scatter in the data. At this point I decided to cut my teeth on a known superhumper.

Figure 2(left), SN2004et in NGC6946. 2004 Oct 6, 9 min exposure (mag

Figure 3 (below), Light curve of SN2003dj in NGC2403.
All are unfiltered measurements, except for those on 2004 Oct 26, 28 and 30, which are V. Start date is 05/09/04, end date 19/12/04, time intervals are one week. Start magnitude is 15.5, end magnitude is 11.5, interval units of 0.5 magnitude.



V1113 Cyg

The first success was on **V1113 Cyg** on 2004 Dec 2. I learnt from Gary Poyner that the star was in outburst, so I carried out a 4 h time series of consecutive 1 min exposures. Photometry was performed using the *Multiple-images* option in AIP4WIN. The raw measurements were then imported into the VSS Excel spreadsheet for reduction. Here, at last, I was able to detect superhumps! The variation was about 0.25 magnitudes, with a mean near magnitude 14.7C. Tonny Vanmunster kindly reanalysed the data using his Peranso software (www.peranso.com; Figs 4 and 5), and found a superhump Period, Psh, of 0.077d. This is within 3% of the published value of 0.0792 d (Kato, T., Nogami, D., Masuda, S. and Hirata, R., 1996, Publ. Astron. Soc. Japan 48, 45-49). Whilst my observation did not represent original science, it did give me confidence in my observing techniques, and fuelled my enthusiasm to continue.

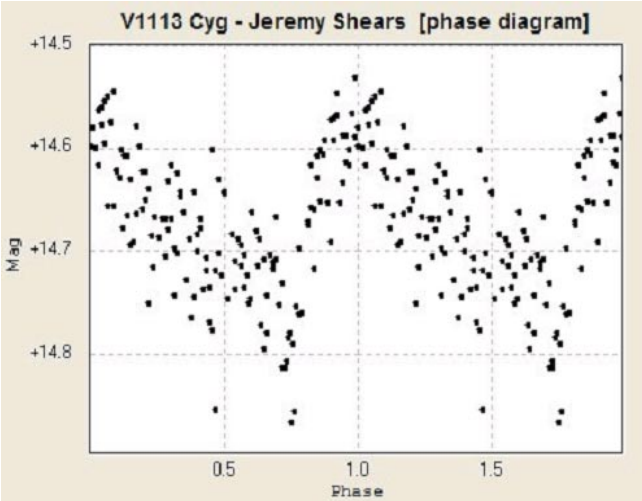


Figure 4. Light curve of V1113 Cyg on 2004 Dec 2, 19.13 to 21.51UT.

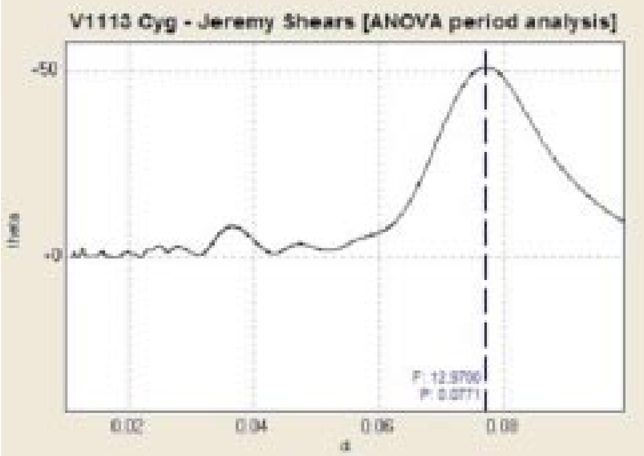


Figure 5. Period analysis of V1113 Cyg. The data used to plot Figure 4 were used for this analysis. With thanks to Tonny Vanmunster.

V542 Cyg

According to Downes et al. in the online Catalogue and Atlas of Cataclysmic Variables (http://icarus.stsci.edu/~downes/cvcat/index.html), V542 Cyg is a probable UGSS star, hence I was not expecting superhumps. It has a range of 13.0P to 18.3P. Given the apparent uncertainty of classification, I thought it was worth a couple of hours of photometry when it went into outburst. However, the results of a 2 h run on the evening of 2004 Dec 19 show no variation in brightness, at 13.5C (Fig. 6)

IW And

IW And is listed in Downes et al. as a UGZ star, although a comment on the Yahoo CV discussion forum suggested that this was not certain, and that a time series photometry run would be worthwhile. To this end, I carried out a run of about 4h 40 min on 2005 January 4, 17.58 to 22.39UT, at which time the star was in outburst (14.0C). However, over this period no variation (eclipses, superhumps) was noted.

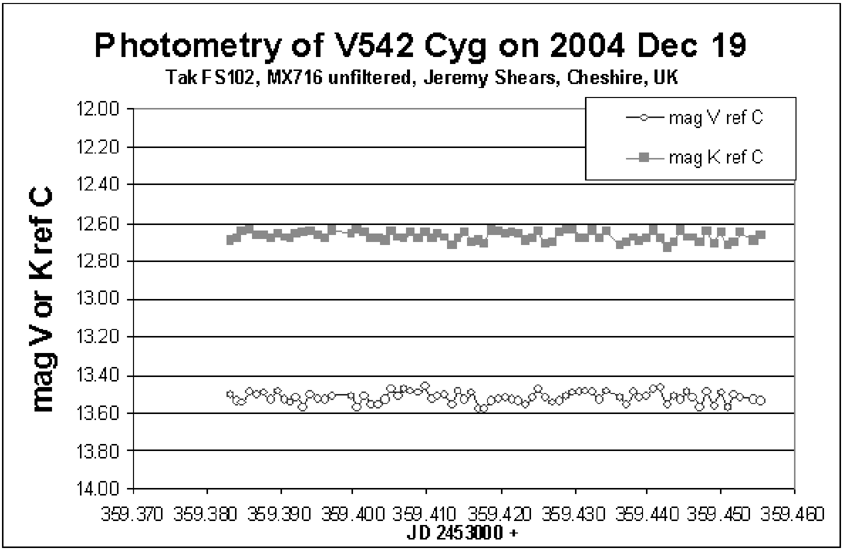


Figure 6. Photometry of V542 Cyg on 2004 Dec 19, 21.11 to 22.55UT. Star C is the star marked 129 on the AAVSO f-chart (preliminary chart, 7/95) NE of V542 and K is star 127 located N of V542

GX Cas

GX Cas was also in outburst in early 2004 January. A 3h 20min time series on 2005 Jan 4 (Fig 7 on inside back cover), shows a complete cycle with a superhump crest-to-trough magnitude range of about 0.3. This is similar to the variation observed during the 2004 Aug outburst, recorded by Nick James (http://www.theastronomer.org/gxcas/aug2000.html). According to Downes et al. GX Cas is a UGSU with a period of 0.089 d. Analysis of my data by Tonny Vanmunster showed a period of 0.090 d.

GY Cnc

This is a star which really does *do something*! It's a deeply eclipsing UG star. The star was in outburst in early 2005 Jan, and I caught a couple of these eclipses. The main challenge to precision photometry is the huge magnitude range of the eclipse. Whilst in outburst the star is pretty bright, about magnitude 13.9, but at mid eclipse it was well below magnitude 16, which is really too faint for my set-up (poor signal-to-noise ratio). Anyway, a typical eclipse is shown in Figure 8 on the inside back cover of this circular.

Acknowledgements

I would like to thank the people who have provided copious quantities of advice and encouragement in my efforts to move up the CCD photometry learning curve, especially Roger Pickard, Gary Poyner, Richard Miles, Guy Hurst and Tonny Vanmunster. There have been others who have also been generous with their time and patience. Thanks to all of you; I didn't believe it was possible to have so much fun in one's back garden with a 4 inch telescope! I'd certainly encourage others to have a go at CCD photometry.

MY FIRST, AND 100,000TH OBSERVATION

PETER WILLIAMS

This is an extract of a private letter sent to John Toone from Peter Williams, in response to a question regarding the subject of his 100,000th observation. It is reproduced here with their permissions.

.....Regarding the 100K observation, yes, this was of the suspected LMC recurrent nova RY Dor. It was made on 2004 November 26.465UT through the 30cm reflector at Heathcote, and the star was fainter than magnitude 13.0 under bright moon.

My first observation is a little less clear. I had been observing a few of the brighter variable stars for about 3 years before submitting observations to the VSS RASNZ. This, in turn, suggests I reached 100K some time earlier, but only counting the reported observations is really a better way to go. The difference would only be several hundred at most, so not a great difference.

I had become interested in variables after seeing a light curve of Mira Ceti in a small soft cover book "The Sky Observer's Guide" by R. Newton Mayall and Margaret Mayall. I thought it would be "pretty cool" (it was the 70s, after all) to see with my own eyes a star change in brightness and perhaps even make a light curve.

My very first observation was of Theta Aps at magnitude 6.0 on 1971 Feb 02UT through 10x50mm binoculars. I drafted my own chart from Antonin Becvar's "Atlas of the Heavens - Atlas Coeli 1950.0" and used V mag stars from the Yale Bright Star Catalogue in the library of the Sutherland Astronomical Society. I followed Theta Aps through to the end of September 1971, recording 2 minima and two maxima and determined a 119 day period from the observations. Norton's Star Atlas of that vintage (and still in use) lists Theta Aps as an irregular variable so it came as a nice surprise to later find out it is currently listed as a semi-regular with essentially that same period.

I then obtained copies of several RASNZ charts and my first observation with these was of the Mira star, R Carinae, at magnitude 6.4 on 1972 January 09UT.

Three years later, I submitted my first observations to the VSS RASNZ, the earliest of these being the Mira star S Carinae at magnitude 7.8 on 1975 April 06UT.

I have observed both R and S Car continuously since that time, and therefore have a near continuous record of their behaviour spanning some 33 years and still enjoy them both. Observation of Theta Aps recommenced in 1993 and a paper summarising results for this star appeared in Publications No.24 (April 2000) of the VSS RASNZ, giving a revised mean period of 115.93 days. Further unpublished investigation of the O-C values suggests the mean period may actually vary over a 5 year cycle, rather than have a fixed period.

This seems like a rather long answer for a relatively simple question but I hope you find it interesting. It has brought back lots of memories for me.

A STAR IS BORN... A GUIDE TO YOUNG STELLAR OBJECTS

Mike Poxon

The concept of star birth is something that has always filled me with awe. Even if for some reason it doesn't do the same for you, it is worth realising that studies of the formation and early history of stars are coming increasingly in demand by the professional community since we can learn a great deal about how stars and also planetary systems are formed. A growing number of amateur observers will be necessary to provide visual, CCD, and multiwavelength observations of these fascinating objects. Oh yes - and they're often fun to observe as well. Some idea of how important visual observations of these stars can be is illustrated in the paper by Guertler et al:

The light variations due to varying circumstellar extinction, open a unique way to study the structure of the circumstellar dust shells, the properties of the individual dust clouds, and the characteristics of the dust grains... However, only the study of the long-term behaviour of the light variations provides information on the statistical properties of the cloud ensemble and the structure of the circumstellar envelope[1].

Without, for the moment, going into the physics above, what is noteworthy is that the sole source of actual raw data for their paper was the AAVSO database! So what are these strange objects, and why should the VSS be interested in them?

Stars are born inside giant clouds of gas and dust when the swirling gas condenses into some sort of core region, whose increasing mass causes the process to mushroom ever further. Eventually a rotating core is formed surrounded by a disc of infalling material. It is likely that this fast rotation produces a magnetic field leading to heavy star spotting, which may be a major source of the observed light variations. Depending on the mass of the object (not strictly a star, since the fusion process has not yet begun) we emerge with one of two types of star. If the mass is between about 0.5 to 2.5 solar, we get a relatively cool T Tauri star, of spectral type G to M. Greater masses produce Herbig Ae-Be stars. When these objects evolve onto the main sequence as bona fide stars, the T Tauri group will become stars similar to the Sun, whilst the Herbig stars will turn into much more massive, powerful stars like Vega. Bear in mind that Vega itself is still surrounded by a dusty disc which may contain planets [2].

The light-curves of T Tauri stars are of fairly small amplitudes, rarely exceeding 1 magnitude, but nevertheless show constant, irregular changes on a fairly gentle scale. Observations more than once a night are not necessary as a rule. Crucial to the process of variation is the behaviour of the circumstellar disc. Due to several environmental factors, the material in the disc may coagulate into definite clumps which may then proceed to grow in size. A planetary system can be formed at this stage. However, some of these regions of matter may be disrupted by the forming star, and smash down onto its surface producing a fairly sudden increase in light output. These phenomena are the FU Orionis stars, formally called slow novae (stars like **RT Ser**, **V1057 Cyg** and **Z CMa**)

In all events, there will come a stage where the embryonic star resembles a bath filling with water. It will fill its equipotential sphere and can take on no more material. Unfortunately, the gas and dust in the disc doesn't know that (the taps have been left on), and must go somewhere (the bath overflows). The excess material can only be emitted through a *safety valve* (the overflow) which, for our forming star, is the region least affected by the mass of the total system - the poles. Matter is expelled from the poles out into the gas cloud. This so-called T Tauri wind is another crucial stage. Without it, interactions between the stellar core and the circumstellar disc would cause the star to break apart! T Tauri winds can not only physically reveal the star to us by evaporating the material in the gas cloud, but can also trigger additional bursts of star-formation by compressing and shifting material in nearby regions of the cloud. Sometimes the outflows are visible as little fan-shaped nebulae, and at other times they show themselves by their effects on the surrounding areas. These are Herbig-Haro objects.

The *interesting variable stuff* happens when we have a system which is edge-on to us, so that the disc, and any material in it, eclipses the star itself. This phenomenon is much more pronounced in the more massive Herbig Ae-Be objects, possibly because the greater mass of the system produces a concomitantly larger dust-grain size which accretes material to it at a greater rate, thus generating larger clumps that obscure the star. These stars in which large (up to about 3 magnitudes) Algol-like dips in light occur are the UX Orionis stars. Indeed, a quick trawl of the GCVS shows that **IL Cephei** is listed there as an Algol star rather than the UX Ori star it actually is!

Observationally, many of these objects are within the range of small telescopes or even good binoculars. Here are a few to be going on with:

Star	Max	Min	Type	Notes
T Tau	9.0	11.0	T Tau	
CQ Tau	8.7	11.6	UX Ori	AE
RR Tau	10.0	14.0	UX Ori	AV
MIS V1147	13.0	16?	UX Ori	AE
RY Tau	8.6	11.0	T Tau	AN
V380 Ori*	8.2	11.1	?	AN
VX Cas	10.0	13.3	UX Ori	A
RW Aur	10.0	13.6	UX Ori	A
VV Ser	11.8	14.5	UX Ori	P
BO Cep**	11.0	13.7	UX Ori	P
WW Vul	10.0	12.6	UX Ori	A

Notes: A = on AAVSO programme; E = extremely active; V = very active; N = attached to or involved in nebulosity; P = chart (unofficial!) by author. *V380 Ori is quite hard to estimate, as it is inside the reflection nebula NGC 1999 and surrounded by Herbig-Haro objects (actually HH1 and HH2, the first discoveries). I have not stuck to the GCVS details religiously, since they are quite clearly wrong in some cases (for example **BO Cep is given a maximum of 11.9 whereas it is usually near magnitude 11.0).

To sum up, nebular variables have so far been under-observed by amateur observers to a degree which is inversely proportional to their importance. Adding a few stars of this type to the observing programme (or, dare one say, initiating a YSO list?) will not only help the professionals, but provide us with some more interesting targets for those rare evenings when the clouds roll back.

References: 1 Guertler,J. et al, Astron. Astrophys. Suppl. Ser. 140, 293{307 (1999)}
2 http://www.gsfc.nasa.gov/gsfc/spacesci/origins/dustdisk.htm

LINEARITY TESTS ON STARLIGHT XPRESS CAMERAS

Richard Miles and John Saxton

CCD cameras as used by astronomers, are remarkable if not magical instruments for collecting and quantifying the intensity of light emanating from astronomical sources. How remarkable they are, can be gauged from precise measurements of their performance in special bench tests. To this end, one of us, John Saxton, has built a device which permits CCD cameras to be illuminated with preset amounts of light so that the response of the cameras can be accurately measured. This device of John's is known as a linearity tester, since it can be used to measure the linearity in response of CCD cameras. It can also measure other characteristics of these cameras, more about which will be described later.

At the recent Pro-Am CCD Photometry meeting held jointly by the VSS and the I&I Sections of the BAA at Northampton on May 15-16, (see **http://www.britastro.org/iandi/meetings.htm**) people attending were invited to bring along their CCD cameras so that they could be put through their paces using John's linearity tester. A total of 4 cameras comprising three models, all manufactured by Starlight Xpress, and all equipped with anti-blooming gates were evaluated in this accurate bench test. This article describes some of the more important findings.

Non-Ideal vs. Ideal Performance

What do we look for in the ideal CCD camera when it comes to photometry? Well one key requirement is good linearity of response. Now let's look at what this means.

Changes take place within each individual pixel each time a photon of light is absorbed. This process is often compared to a bucket or well, which accumulates photoelectrons as light is collected, rather like water in a container. For a perfectly linear response, all of the water remains in the container and when the CCD chip is read out, all of the water (charge) is quantifiable. However, for some chips, especially those equipped with anti-blooming gates (ABG-type), as is the case for the Sony chips used in most Starlight Xpress cameras, as the bucket fills some of the photons leak away via the anti-blooming gate. The more the bucket has been filled, the greater the proportion of photons that escape.

This all sounds very serious and many people have criticised the use of ABG-type CCD cameras for accurate photometry. However, few, if any of the critics, have tried to measure the degree to which ABG-type cameras are non-ideal. We have done so here and we are sure you will be surprised by the results.

How the Linearity Tester Works

Most attempts to quantify linearity of response have gone down the route of varying the exposure of the camera to a continuous light source of constant intensity. Of course if timing errors creep in at say the shorter exposure times, then this will be evidenced by an apparent non-linearity. A much better approach is to set up a light source that switches on for a predetermined time interval, the amount of light then being proportional to the time period that the source is on. In the case of John's device, an accurate quartz timer switches on a voltage-stabilised LED for time intervals of 1.000ms (millisecond), 2.000ms, 3.000ms, etc. through to 99.000ms. The camera on test is fitted without any lens in a light-tight box so that the light from the LED uniformly illuminates the entire CCD chip at a distance of about 30 cm. The camera is typically set to an exposure time of 4 seconds, during which period it is exposed to a single flash of the light for a preset number of milliseconds. Sequential 4-second exposures are made by changing the flash duration between 0 and 99 ms in a randomly chosen manner.

The CCD response is derived by taking the average of the entire pixel values on the chip in each image (avoiding any edge effects if present), and first subtracting off the equivalent measure for the 0ms (i.e.) dark frame. The resultant average ADU (analogue to digital units) measure for each frame is then divided by the time in milliseconds to arrive at a normalised average response in terms of ADU/millisecond. For an ideal linear response, this normalised average response should remain constant independent of the mean pixel value up to the maximum pixel value of the camera (usually 65535 ADU). In practice, the normalised response varies slightly. To represent this we have ranked the response relative to an arbitrary intermediate value set at 100%. And now to the results:

MX 516 CCD CAMERA

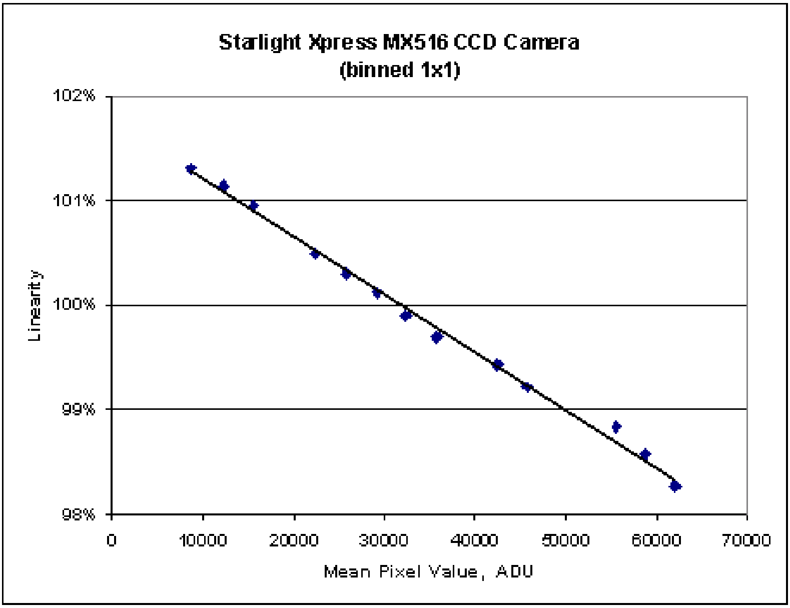


Figure 1, Result of Linearity Test for the Starlight Xpress MX516 binned 1x1

Figure 1 above, shows the first result obtained using an MX516 camera provided by Steve Johnston. The camera was operated without any binning of adjacent pixels, i.e. binned 1x1. In the lower half of the dynamic range, the response is slightly greater by about 1%, whereas the converse is true in the upper half of the range. So we might expect photometric measures spanning a wide range to be accurate to about +/-0.01 magnitudes. If the observer ensures that images remain in the lower half of the dynamic range (i.e. less than about 33,000 ADU/pixel), then the potential accuracy increases to around +/- 0.005 magnitudes.

What is surprising about Figure 1 is that the departure from linearity is itself linear to a high degree! Furthermore, there does not appear to be any increased *roll-off* of response towards the top end of the range. This roll-off of the response is a common feature of ABG-type cameras, but whether it is present depends upon the way the A-to-D converter is set up. Clearly with Steve's MX516, no roll-off in response is apparent as it approaches saturation, which is a great situation if he wants to use the camera for photometry.

The linear nature of Figure 1 also begs the question, *Why not build in a step in the image processing which takes each pixel ADU value and recalculates the 'true' value by multiplying the each pixel value by a linearising factor, which itself depends solely on the ADU level?* In the case of Steve's camera this would be a simple linear function of the pixel value, and would vary by about 3% across the entire dynamic range. Such an approach would in effect ensure that the resultant photometry is linear to better than 0.001 magnitude or thereabouts. We shall have to see whether any future updates to existing photometric software packages incorporate such a linearisation step.

MX 916 CCD CAMERA

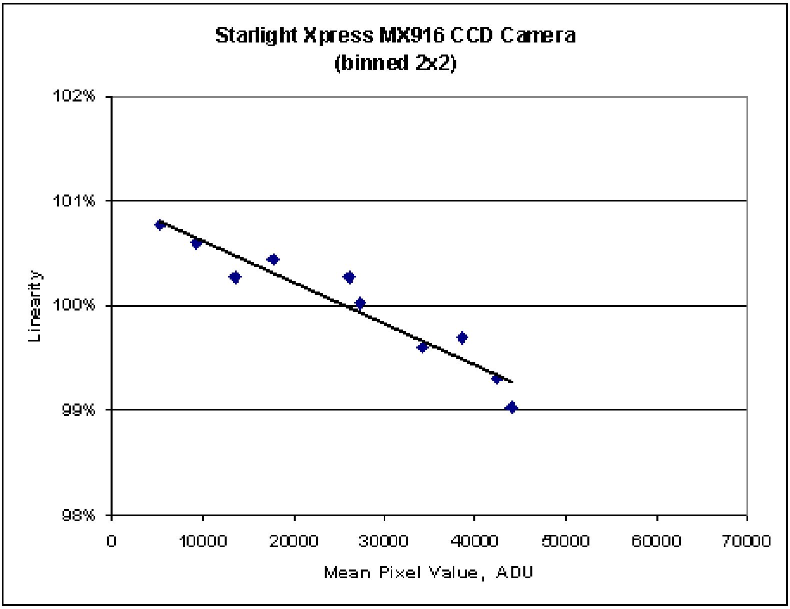


Figure 2, the Result of the Linearity Test for the Starlight Xpress MX916 Camera

The next camera that was tested at the Northampton meeting was a Starlight Xpress MX916. Some of the results obtained are shown in Figure 2 above. Here we can see a similar response to that of the MX516 camera, although we did not extend the tests beyond about the two-third point of the dynamic range, so that it is not certain whether a roll-off of the response occurs at the top end. The degree of non-linearity can be quantified in terms of the slope of the linear regression shown in Figure 2, which equals 0.39% per 10,000 ADU. For the MX516, this measure of non-linearity equates to 0.55% per 10,000 ADU, i.e. slightly poorer than for the MX916.

SXV-H9 CCD CAMERA

Two examples of the latest Starlight Xpress monochrome camera, the SXV-H9, were tested. Figure 3, shown below, is typical of the observed response of both cameras. Over the lower two-thirds of the dynamic range (up to 43,000 ADU), the non-linearity was found to be 0.20% per 10,000 ADU and 0.23% per 10,000 ADU. Clearly the latest ABG camera from the Starlight Xpress stable is a further improvement in terms of linearity compared to previous models, and provided the observer stays in the lower two-thirds of the unbinned operating range, the resultant photometry should remain linear to few millimagnitudes. As well as evaluating the change in the average pixel value with exposure, it is also worthwhile looking at the noise or standard deviation in the mean level at different exposures. The reasoning here, is that the increase in noise over that of the bias level, arises as a result of the inherent variability of the photon flux.

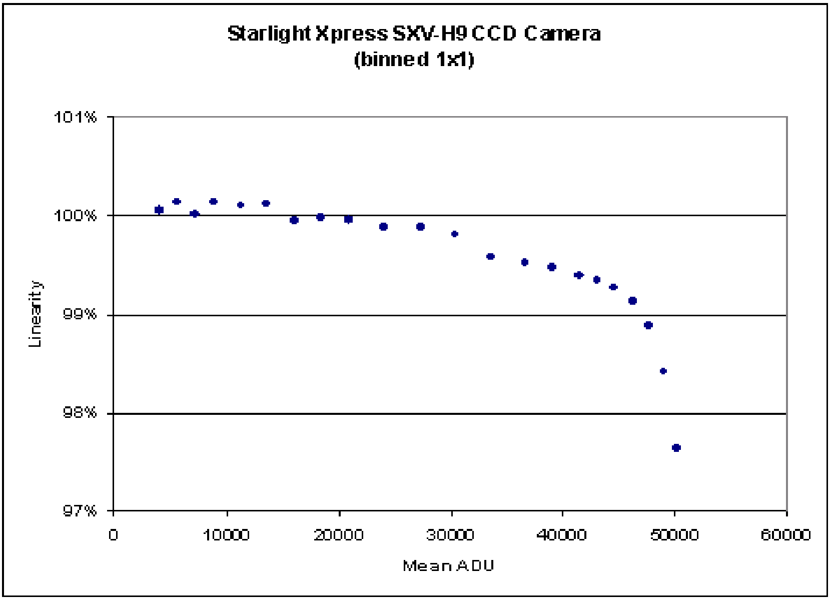


Figure 3, Result of the Linearity Test for the SXV-H9 Camera

So if a pixel registers say 10,000 photoelectrons, this component of the noise would amount to 1% of the signal (square root of 10,000). Knowing that CCD cameras obey Poisson statistics in this way, it is possible to carry out an analysis of the increase in noise with signal, so as to calculate how many photoelectrons equate to 1 ADU. This quantity depends on the electronics which readout the CCD chip, and can vary considerably. An approximate value is sometimes given in the manufacturer's specification for the camera and is sometimes referred to as the *gain* expressed in electrons/ADU. However it is always best to measure the effective gain of any camera rather than assume its value from the specifications for that camera model.

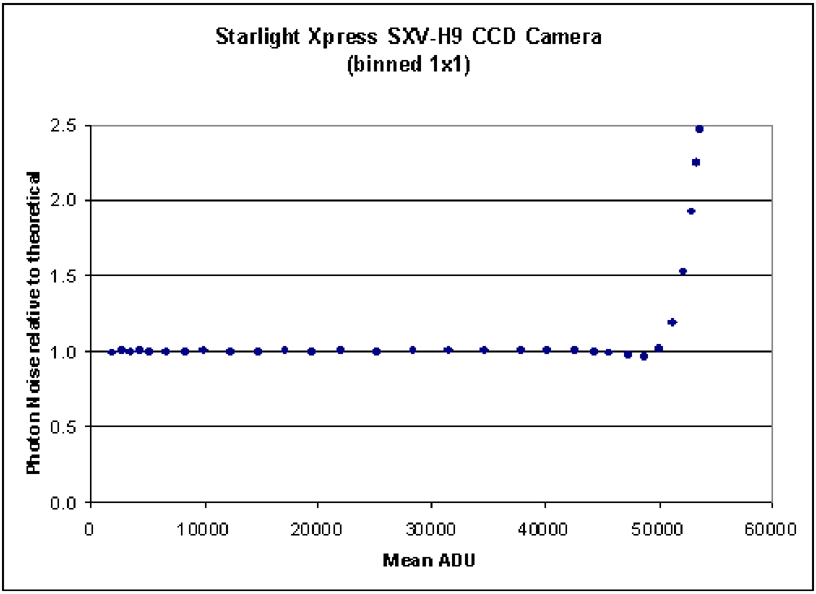


Figure 4, Increase in Noise with ADU Counts per Pixel

An analysis of the gain for each of the SXV-H9 cameras yielded values of 0.343 +/- 0.004 and 0.347 +/- 0.006 e-/ADU, showing that the two cameras have been set up virtually identically. This analysis revealed another characteristic that was quite unexpected. As the roll-off in response increasingly kicks in above about 50,000 ADU when the response drops off by 2% or more, the observed noise suddenly begins to increase over and above that predicted by Poissonian statistics as depicted in Figure 4.

Such a characteristic must arise as a consequence of the anti-blooming feature of these cameras, and indicates that the SXV is unsuitable for photometry when operated beyond 50,000 ADU (equivalent to 17,000 photoelectrons) in un-binned mode.

The SXV-H9 was subjected to a more in-depth evaluation in that the camera was also operated in 2x2 and in 3x3 binned mode. Since this camera has quite small pixels, as a norm, many observers who use the camera operate it in 2x2 mode, equivalent to a pixel size of 12.9 micron. Doing this has the disadvantage that it reduces the effective dynamic range before saturation is reached, but as we can see from Figure 5 it also has the effect of ensuring very satisfactory linear response across the entire range of ADU values. The non-linearity is also lowered to values of 0.13% and 0.15% per 10,000 ADU for the two cameras tested.

When binned 3x3, non-linearity was reduced even further to 0.07% per 10,000 ADU as shown in Figure 6.

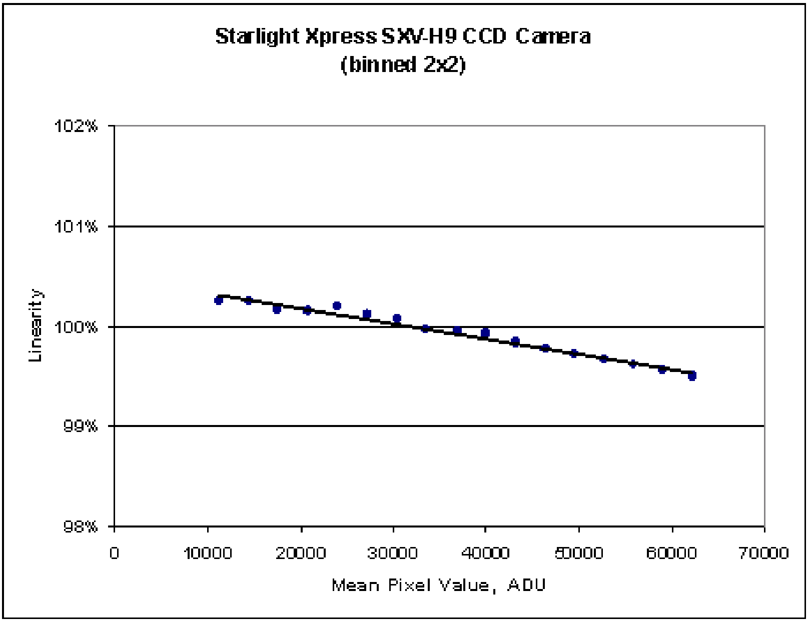


Figure 5, Linearity of SXV-H9 in 2x2 binned mode

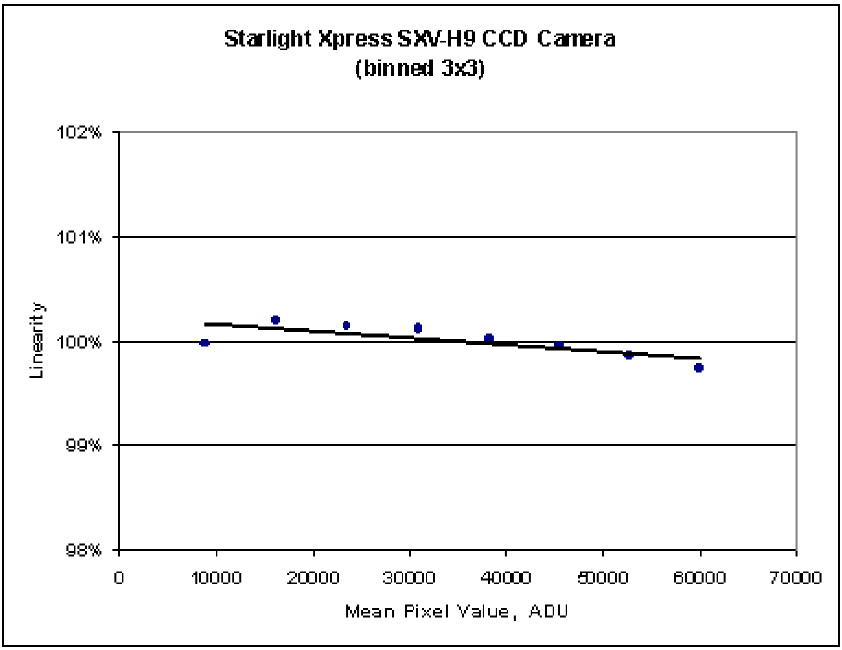


Figure 6, Linearity of SXV-H9 in 3x3 binned mode

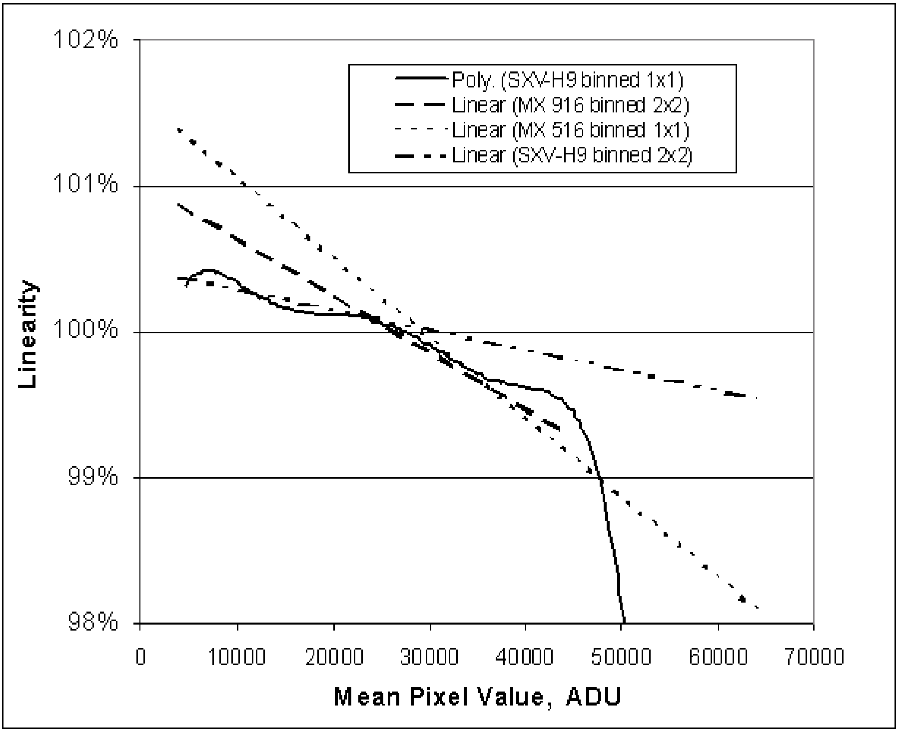


Figure 7, Linearity of all Systems for Comparison

Finally, let's now compare the three camera models by plotting their linearity characteristics on the same graph as shown in Figure 7. It can be seen that, as a general rule, adjusting exposures so that pixel values remain in the lower half of the dynamic range ensures good linearity is achieved when cameras are used unbinned. Switching to 2x2 binning has the effect of making the entire dynamic range useable in the case of the SXV-H9. However if this camera is used for photometry of relatively bright stars it is best to operate unbinned, since useable pixel well-depths reach to more than 15,000 photoelectons as opposed to only 5,000 photoelectrons in 2x2 mode.

In presenting this article, we hope to have dispelled some of the myths surrounding the use of ABG-type cameras for accurate photometry. Clearly, more investigation of different camera types would be helpful, but these findings do demonstrate that millimagnitude photometry is, in principle, possible using these devices. The article may also prompt some software developers to introduce a *linearization* option in their image processing routines. Let's hope so.

LETTERS

The CCD Equation and Sky Conditions, from Mike Peel

The CCD equation (CCDE) is a method for estimating the signal to noise ratio (SNR) in CCD photometry. It makes impressive claims, and has attracted users through its appearance in a widely cited book by Howell [1], where its application to observations made in *typical conditions* seems to be endorsed. However, instead of conditions typical of Britain, what Howell seems to mean are *typical conditions* at good observatory sites, where skies are stable enough for absolute photometry. Needless to say, in Britain these are atypical, but we can still do useful differential photometry.

The unreliability of the CCDE in unsuitable conditions can be shown by simple numerical experiments. The CCDE uses the number, P, of photons from a star detected in any single exposure. In addition, it requires numbers of pixels, photons, electrons, and electrons squared, which occur as parameters of the camera or observing conditions. The latter are combined in an expression, effectively a constant for a sequence of exposures, which we can call E. The CCDE then claims the measurements have **SNR = P/ sqrt(P + E)**. The bigger the SNR, the better the measurement. This estimate must be treated with caution. The CCDE assumes crucially that the atmospheric transparency is constant during the time you are making the observations. Only then, does its essential ingredient, the Poisson distribution, describe correctly the spread of photon numbers. The spread must emerge by chance, like the score in a game with fair dice, for example. Consistent with *typical conditions*, it must not come from changes in transparency. If it does, the Poisson model and the CCDE collapse. Imagine the above observation is the second of three. Suppose transparency is increasing about 5% per observation, so that we detect from this star 95,000, 100,000 and 105,000 photons in successive exposures. The CCDE gives no warning of its predicament, claiming the SNR is still about 250; to be precise, it gives 241, 250 and 258 respectively.

However, a universally accepted estimate of the SNR that makes no assumptions about the origin of the numbers can be made using basic statistics. In this way the noise or sample standard deviation can be calculated,

$$\textbf{Sample Standard Deviation} = \sqrt{\Sigma_{\iota}(x_i - x_{mean})^2 / (n-1)}$$

where x_i are the photon numbers, and n is 3. In this way, we estimate the noise to be 5,000 photons; the mean signal 100,000; and the SNR = 100,000/5,000 = 20. Without question, 20 is a more convincing estimate than 250. The CCDE result is unsupportable because the Poisson distribution is not a satisfactory model for the spread of the photon numbers. The changing mean signal rules it out. The CCDE is generally not a convincing way to estimate the SNR of observations made in skies notoriously subject to change, although some of its estimates might agree with those derived more reliably.

References

1. Howell, S. B.,Handbook of CCD Astronomy, Cambridge University Press, 2000.
2. Boyd, D. What photometric precision can I achieve?,VSSC, No 119, March 2004.

Views expressed in letters, are those of the author, and do not necessarily represent views of BAA officers. Responses to letters may be sent to the editor for publication.

ALSTON HALL VSS MEETING, 22ND-24TH OCT, 2004

KAREN HOLLAND

The meeting began on Friday 22nd with a welcome from **Roger Pickard** and **David Boyd**, at the now familiar location of Alston Hall, Preston. Alston Hall, as previous visitors will know, is, without doubt, the favourite location for astronomically-themed residential courses. The accommodation is very comfortable; facilities for meetings are good; the food is excellently prepared, and there is a bar in which to while away the evenings, talking to like-minded astronomers! What more can I say?

After lunch, **Tony Markham** got the meeting off to a good start talking about *Sources of Scatter and Error*. I will not summarise this talk here, as it has been published in great details in VSSC numbers 118,119, 120, and 121.

This was followed by the VSS team quiz challenge first heat, in which four teams pitted themselves against each other in a bid to see which team could amass the greatest number of points in a general knowledge and an astronomy quiz round.

Roger Dymock followed with a talk on *Project Quixote - The Variable Star Section Online Database*. His presentation described the first steps that had been taken towards putting all of the BAA's observational data on-line. The name Quixote, had been chosen, as Quixote was an enthusiastic visionary and pursuer of lofty but impractical ideals. This had seemed like an ideal name for a project that, at first seemed like an impossible task.

The primary goal of the project was to create an on-line database of (initially) VSS visual telescopic data, from which data could be extracted by observer, year or star, and light curves could be created by star and by period of time.

The reason for developing such a database were numerous:

- Data could (and has, in the past) been lost, when a section director and the BAA have parted company, or due to natural disasters (Enhanced protection of data).
- An on-line database allowed BAA members and the wider astronomical com munity easy (controlled) access to observational data (Enhanced access to data).
- Data would be readily available, and would be backed up. Original data could be stored in a secure central location (Reduced storage space required in section officer's homes).
- Members could more easily provide support to sections with data analysis, and in the longer term, direct data input would be possible (Enhanced assistance to Officers in analysis and direct data entry).
- The formation of a database would provide the first small step towards a virtual observatory, which is in-line with the current aims of professional astronomers (Enhanced forward-looking image for BAA).

In January 2003 the initial proposal was made to the BAA council that this work should begin. A number of meetings followed, during which time the basics were discussed, and Tim Naylor, of Exeter University, offered to host the database at that University. Roger set about learning the necessary basics to be able to start to design the system and formed the off-line database by February 2004. By August 2004, the on-line database had been completed and was operational at Exeter University.

Roger described in some technical detail, how he had built the database with its password-controlled web interface, and showed slides that showed how the database pages looked when accessed. He performed a demonstration of the operation of the system.

The total cost of developing the system to date was £143, and it was expected that the system would go live at the end of the first quarter 2005. There were still some enhancements to be made in the future involving improvements to data selection and output, and he showed some slides to indicate how these might look in the future. It was likely that there would be links to star charts, BAA journal articles, images and other databases in the future

After Afternoon Tea, **Bruce Sumner** covered the *Perils and Pitfalls in sequence Making*.

Bruce stressed the fact that there were many steps in making a good comparison star sequence. During the past decade several all-sky photometric surveys had taken place, or were underway that were revolutionising our ability to make good sequences, but these surveys also had many limitations. What Bruce wanted to talk about were other more traditional sources of star magnitudes that could (and should) be used for sequences at the present time.

This talk looked at all these sources and their limitations, plus other issues that need to be addressed in determining a magnitude sequence.

Bruce began by stressing the importance of checking facts such as the position, the variable star range, the identification of comparision stars, and not necessarily believing all that was published without question. Old sequences were not necessarily ideal as the basis for the formation of new sequences, and all options should be considered. Comparison star selection could be made using multiple source catalogues, as individual sources were notoriously incomplete (and incorrect). All magnitude sources should be used with suspicion.

He then went on to detail some of the sources that could be used for comparison stars, and discussed their strong points, whilst also pointing out their limitations. He discussed the pros and cons of the General Catalogue of Photometric Data (GCPD), the All-Sky Automated Survey (ASAS-3), the Two-Micron All Sky Survey (2MASS), the Amateur Sky Survey (TASS), Tycho-2, Henden photometry, the Hipparcos Input Catalogue and the Hipparcos Catalogue, the USNO CCD Astrometric Catalog (UCAC), and USNO B1.0.

In summary, he stressed that observers should know their data and its limitations; should not limit their investigations, but must think laterally; and finally, they should believe nothing until it had been checked.

The next speaker was **John Toone**, who talked about *Two Pioneering Lancastrian VS Observers*. In this first talk, he spoke about Joseph Baxendell a keen variable star astronomer who lived between the years of 1815 and 1887. He was born in Manchester the eldest son of Thomas and Mary; the family comprised 6 sons and 2 daughters. It may be that his love of astronomy was derived from his mother, who was an avid observer, and knew the constellations and planets well. Having as somewhat delicate constitution, and in an effort to make him more robust he set sail on a voyage to South America at the age of 14, and impressed the captain with his sailing skills. He not only witness the leonid meteor storm of 1833, but also attempted to determine the radiant during the shower. He survived the pacific eathquake of 1835 whilst still at sea. On returning to the UK, he assisted his father in his business, whilst using the observatory of a friend, Robert Worthington, and in 1857 he was elected a fellow of the RAS. In 1859 he was appointed astronomer to the corporation of Manchester, and in 1865 he married Mary Anne Pogson, the sister of Mr Norman Pogson, the Government Astronomer of Madras. In 1877 he established a private observatory at Birkdale in Southport, and his observing career was distinguished in 1884 when he was elected a fellow of the Royal Society. John presented many of Joseph's observations from his lifetime, showing the records that he had tracked down.

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 Apr 3, U Cep D20(21)25 indicates that U Cep will be in mid eclipse at approx 21h UT. The eclipse will be observable between approx 20h UT and 01h UT on Apr 4, with the start of the eclipse having occurred during daylight. Please contact the EB secretary if you require any further explanation of the format.

The variables covered by these predictions are :

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

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

Two long period eclipsing variables have eclipses due during this interval. These are **RZ Oph** (mid eclipse Apr 06) and **OW Gem** (Jun 15), although the latter will be too close to solar conjunction to be observed. For further details, see VSSC 114.

2005 Apr 1 Fri
del Lib 00(06)04D
S Equ L03(06)04D
Z Per L04(08)04D
U CrB D19(17)23
TV Cas D19(22)26
2005 Apr 2 Sat
Z Dra D20(19)22
TW Dra D20(23)28D
2005 Apr 3 Sun
TV Cas D20(17)22
U Cep D20(21)25
RW Tau D20(22)23L
Z Vul L23(22)27
2005 Apr 4 Mon
Z Dra 01(04)04D
RS CVn 01(08)04D
U CrB 22(28)28D
U Sge L24(19)25
2005 Apr 5 Tue
TW Dra D20(19)24
X Tri 20(23)20L
del Lib L22(22)28D
2005 Apr 6 Wed
Z Vul 03(09)04D
RW Tau D20(17)21
Z Dra D20(21)23
X Tri D20(22)20L
2005 Apr 7 Thu
TX UMa D20(16)21
X Tri D20(21)20L
U Sge L23(28)28D
del Lib 24(30)28D
2005 Apr 8 Fri
S Equ L02(03)04D
Z Dra 03(05)04D
U CrB D20(15)21
U Cep D20(20)25
X Tri D20(21)20L
RS CVn 21(27)28D
SW Cyg 21(27)28D
Z Vul L23(20)25
TV Cas 24(28)28D
2005 Apr 10 Sun
TX UMa D20(18)22
HU Tau D20(18)22
X Tri D20(19)20L
TV Cas D20(23)28
Z Dra 20(23)25
2005 Apr 11 Mon
Z Vul 01(06)04D
U Cep 03(08)04D
X Tri D20(19)20L
U CrB 20(26)28D
2005 Apr 12 Tue
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TV Cas D20(19)23
HU Tau D20(19)22L
del Lib L21(22)28D
2005 Apr 13 Wed
SW Cyg D20(17)23
TX UMa D20(19)24
U Cep D20(20)25
RS CVn D20(22)28D
TW Dra 24(29)28D
2005 Apr 14 Thu
HU Tau D20(21)22L
RW Tau D20(24)22L
Z Dra 22(24)27
U Sge L23(22)28D
del Lib 23(30)28D
2005 Apr 15 Fri
S Equ L02(00)04D
Z Vul 23(28)28D
2005 Apr 16 Sat
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TX UMa D20(21)25
HU Tau D20(22)22L
TW Dra D20(24)28D
2005 Apr 17 Sun
RW Tau D20(19)22L
2005 Apr 18 Mon
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2005 Apr 19 Tue
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del Lib L21(21)28D
2005 Apr 20 Wed
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Z Vul L22(26)28D
2005 Apr 21 Thu
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Z Dra D20(19)22
TV Cas D20(20)25
del Lib 23(29)28D
2005 Apr 22 Fri
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U Cep D20(19)24
2005 Apr 24 Sun
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RW Tau D20(20)21L
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del Lib 22(29)27D
2005 Apr 29 Fri
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U CrB D21(19)25
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2005 May 4 Wed
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2005 May 13 Fri
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2005 May 18 Wed
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2005 May 27 Fri
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TW Dra 22(27)26D
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2005 May 30 Mon
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2005 May 31 Tue
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TW Dra D22(22)26D
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2005 Jun 2 Thu
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Z Dra D22(21)24
SW Cyg D22(24)26D
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2005 Jun 3 Fri
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2005 Jun 4 Sat
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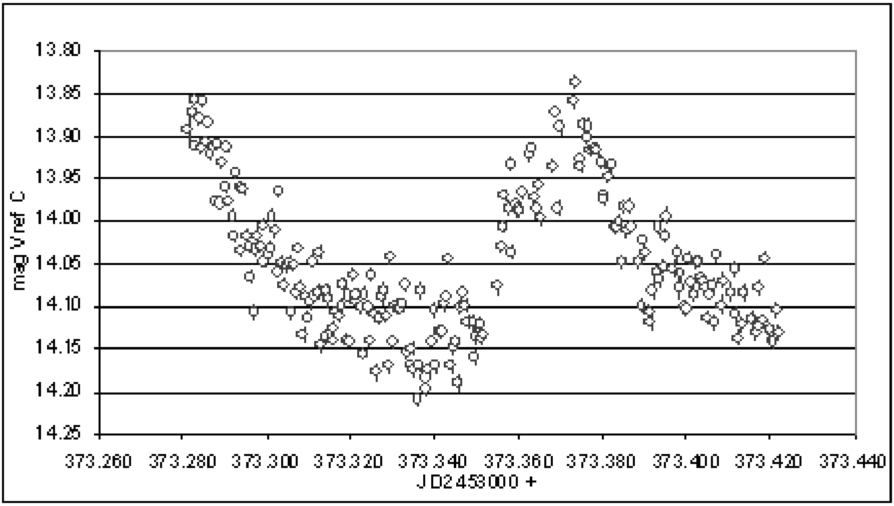

Figure 7. GX Cas, 2005 Jan 02, 18.45 to 22.07UT (see page 16 for more details)

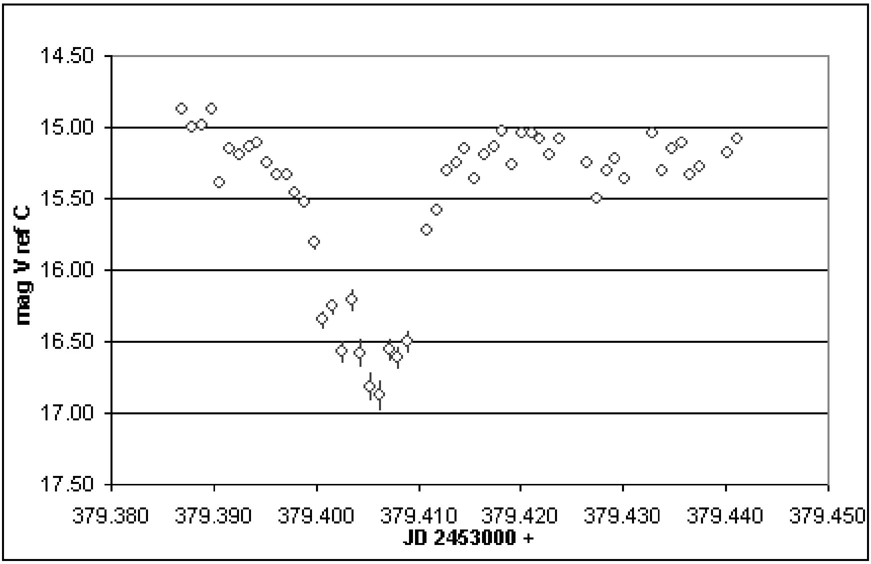

Figure 8. GY Cnc, 2005 Jan 8, 21.17-22.35UT. C= 137, K=135 (see page 16)

The deadline for contributions to the issue of VSSC 124 will be 7th May, 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.

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SECTION OFFICERS

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

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

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

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

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

Eclipsing Binary Secretary Tony Markham
20 Hillside Drive, Leek, Staffs, ST13 8JQ
T: 01538 381174
E: tonymarkham@compuserve.com

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

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

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

Webmaster David Grover
12 Lonewood Way, Hadlow, Kent, TN11 0JB
T: 01732 850864
E: david.grover@virgin.net

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 01284 828431.

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

BAAVSS web pages:http://www.britastro.org/vss

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