The Variable Star Section CCD Target List Rev 010805

Introduction

It was probably about ten years ago, that amateurs first eagerly started to buy CCD cameras, which previously had been available only to professionals at world-class observatories. The proud owners of these CCD cameras were astounded at their sensitivity to light, and were completely seduced by the computer interface that allowed them to process their images so easily. Users started to produce spectacular images, first in black and white, and then, later, in colour too. Being quick off the mark, amateurs rapidly realised that they also had a tool that would allow them to compete with the professionals; if they could learn to do photometry, they could unlock the secrets of the systems from which the light came.

Over the years, we have learnt a good deal about how to do photometry well; however, we still have much to learn. It was with this in mind, that the Variable Star Section decided in 2002, that it was time that we should produce a CCD target list, in the same way that we have a telescopic priority list, a recurrent object list, and a binocular list. Having a CCD target list does not stop anyone from observing whatever objects they are personally interested in, but it does gives the growing number of CCD users who wish to learn to make good measurements, some focus to their work. It means that the relatively small number of CCD observers who want to do good photometry can work on obtaining measurements on the same systems; in that way they can compare their results, and discuss methods and reduction techniques whilst working on the same objects.

As there are a relatively small number of CCD observers in the UK, it is important, if we want to contribute useful data, that we combine our efforts to work on a well-focused group of projects. We should also aim to produce high quality data that can be re-reduced at a later date if necessary. In this way, professionals will come to trust the quality of our data, as they do currently, with our visual database. *High quality* is not the same thing as high accuracy; high quality implies that the data should be exactly what it claims it is: a magnitude measurement of 12.5+/-0.5 is a high quality measurement if it is exactly that; future analysts of the data can then be confident of the error on the data. Of course, the more accurate our measurements are, the more useful they are for some applications, but the important thing is that the consumers of our data should have confidence in its integrity.

The CCD target list that has been compiled, will continue to be regularly updated and revised, to reflect the interests of section members and to take account of feedback that is received. The projects have been deliberately divided to fall into five categories, described below, of increasing difficulty. It is suggested that observers who are completely new to CCD camera use, might wish to begin work on projects in the Beginners category, and progress to the subsequent levels as they become confident in each level. The VS section has a CCD advisor, Richard Miles, who is happy to assist with queries, and his article on CCD observing (UBVRI photometry using CCD cameras, 1998, R. Miles, J.Brit.astron.Assoc.,108(2), 65-74) is well worth consulting for a good, general background. The VS section also runs a mentoring scheme, which pairs new observers with more experienced observers, for guidance and support where required. If you would like to be allocated a mentor, please contact Karen Holland.

The list that was produced in 2002, has now had its first revision, and information regarding the newly revised list is included here. Sequences for these stars are available on the web pages at http://www.britastro.org/vss/comps_all_charts.PDF. For the majority of stars a sequence will be defined as a list of suitable comparison stars; only in cases where there may be some difficulty identifying the variable will a chart be produced.

Changes to the target list for revision 1

LL Lyr has been dropped from the programme, partially due to the difficulty in observing it due to its proximity to Vega, but also because the primary reason for observing it was to obtain a determination of the orbital period, and a value for this has now been published.

The comparison star sequence for ***HT Cas*** has been updated

The new category of objects called the Beginners' category has been added. This is a list of ***bright fast eclipsing binary stars***, that are ideal for new observers to use whilst testing out their equipment and methods.

New stars which have been added are ***V402 And, V630 Cas, V336 Per, DV Dra, V358 Lyr, V452 Cas, CI Gem and 1502+09 Boo***. These are all quite faint, and are likely to be dwarf novae. Because they are too faint for observing by the majority of visual observers, many of their outbursts are likely to be missed. It is hoped that CCD observers will monitor these objects carefully, for the detection and notification of outbursts. VSS Charts exist for all these stars except 1502+09 Boo.

Four stars from the ICCE programme have been added. These are **V720 Cas**, **TAV 0714+17**, **J0712+296**, **TAV1933+53**.

Beginners Category

Star	RA(2000)Dec	Type	Max	Min I	Min II	Orbital Period	Comp V Mag	Comp GSC No	Data source
AD And	23 36.7 +48 40	EB	10.9	11.6p	11.6	0.99d	10.93	3641 0339	A
OO Aql	11 19.8 +09 18	EW	9.2	9.9	9.8	0.51d	10.25	1058 409	A
AC Boo	14 56.5 +46 22	EW	10	10.6	10.6	0.35d	9.39	3474 966	A
EG Cep	20 16.0 +76 49	EB	9.3	10.2	9.6	0.54d	9.6	4585 413	A
TZ Lyr	18 15.8 +41.07	EB	10.6	11.3	10.8	0.53d	10.06	3107 2554	A
ER Ori	05 11.2 –08 33	EW	9.3	10.0	10.0	0.42d	9.25	5330 364	A

Basic CCD Data

Star	RA(2000) Dec	Type	Range	Orbital Period	Data source	Notes
V1363 Cyg	20 06 11.6 +33 42 37.7	VY[H]	13.0p-<17.6p	?	C	1,*,**
V1454 Cyg	19 53 38.5 +35 21 45.4	UGSS?	13.9-20.5	?	C	1, *
CG Dra	19 07 32.8 +52 58 29 1	UG?	15 -17.5	0.1893d	B	1, *
V650 Ori	05 31 08.8 +09 45 27.7	UG?	15.5-<17.5	?	C	1, *
V402 And	00 11 07.3 +30 32.36	UGSU	15.5p-20.3B	?	C	*
V630 Cas	23 48 51.9 +51 27 39 1	UG:[I]	14.3-16.6	?	B	*
V336 Per	03 22 53.9 +41 37 01.4	UG	14.3-19.7	?	C	*
DV Dra	18 17 23.10 +50 48 18.1	UGWZ[J]	15.0B-<21.0p	?	C	*
V358 Lyr	18 59 33.0 +42 24 12.2	UGWZ[K]	16.0p-<20.0p	?	C	*
V452 Cas	00 52 18.1 +53 51 51 1	UGSU	14.5 -17.5	?	B	*
CI Gem	06 30 05.9 +22 18 50.7	UGSS:/UGSU[L]	14.7-18.5p	?	C	*
1502+09 Boo	15 04 41.8 +08 47 54	CV[M]	?-18.5V	?	D	*

Precision Timing Data

Star	RA(2000) Dec	Type	Range	Orbital Period	Data source	Notes
ES Dra	15 25 31.8 +62 01 00.1	UGSU[O]	>15.4	0.179d	B	*
KU Cas	01 31 02.48 +57 54 13.3	UGSS	13.3p-19.7B	?	C	*
TZ Per	02 13 51.0 +58 22 53.1	UGZ	12.3-15.6	0.263d	B	*

Approximate Differential Photometry

Star	RA(2000)Dec	Type	Range	Orbital Period	Data source	Notes
NSV2249 Tau	05 35 30.0 +23 52 59	M?	10.7-16.4p	?	E	2
HU Aqr	21 07 58.3 –05 17 39 1	NL/AM	14.7-20.0	0.087d	B	2, *
HT Cas	01 10 13.0 +60 04 36 1	Ecl UGSU	10.8-18.4	0.073d	B	1, 2, *
GO Cnc	09 17 38.13 +16 42 18.2	EA	8.3-8.8	3.65d	F	
NSV 04031 Lyn	08 22 58.6 +45 27 24	EA	8.0-8.8	?	F	1
V720 Cas	00 45 +53 26	SR?	12.4??-13.6??		ICCE	
TAV 0714+17	07 17 +17 54	SR?	10.5-12.2		ICCE	
J0712+296	07 12 +29 38	Lb?	11.3-13.8		ICCE	
TAV 1933+53	19 34 +53 53	?	10-16		ICCE	

Precision Differential Photometry

Star	RA(2000)Dec	Type	Range	Orbital Period	Data source	Notes
SS Cyg	21 42 42.7 +43 35 10 1	UGSS	8.2-12.1	0.275d	B	
GY Cnc	09 09 50.6 +18 49 47 1	UGSU+E[N]	12.5 -17.6	0.175d	B	*
				Cycle length		
VZ Cam	07 31 04.48 +82 24 41.6	SR	4.9+/-<0.2	? ~23.7d	G	3
CO UMa	11 09 19.11 +36 18 34.0	Lb?	5.8+/->0.2	?	G	3
AT Dra	16 17 15.34 +59 45 17.9	Lb	5.5+/->0.2	?	G	3

Data Sources

Data is derived according to the code given in the Data source column of the table, except where an individual item has a superscripted note, in which case, this item only is from the indicated source. Data sources are as follows:

A BAA Variable Star Eclipsing Binary programme (web page)
B Ritter and Kolb RKcat Edition 7.4 (01/01/05): Ritter, H., Kolb, U., 2003, A&A 404, 301 (update RKcat 7.4)
C Downes and Shara: The Catalog and Atlas of Cataclysmic Variables (2001, PASP 113, 764)
D BAA Variable Star Telescopic programme (web page)
E A Mike Collins discovery, suggested by Chris Jones
F Tony Markam – Eclipsing Binary Secretary VSS
G Albert Zijlstra and Tim Bedding
H Bruch and Schimpke 1992 (A&AS 93,419)
I IBVS 797
ICCE From the Variable Star Section ICCE Programme
J IBVS 3626
K IBVS 5544
L Observation (Gary Poyner) and IBVS 4757
M PASP 97, 41, 1985, and private email to G Poyner from T Kato
N Baade et al A&AS 127, 145, discovery paper
O Vanmunster, http://users.skynet.be/fa079980/cv_2001/Dra_ES_jun_2001.html

Notes

1 A CCD chart is available for clarification of this sequence; see web pages
2 Great care must be taken in identifying the variable and comparison stars. The GCVS positions given can be poor at times
3 These 3 stars were selected as being the easiest to observe; however, the list contains many more stars, which can be supplied if required.
* Alert if rising in magnitude, inform Director and Gary Poyner
** Alert if fading in magnitude, inform Director and Gary Poyner

Explanation of types

The following abbreviations are used in the 'Type' column, where the type is known or suspected:

AM: AM Her stars, polars, usually at maximum, declining to minimum at irregular intervals
CV: Cataclysmic variable (type unknown)
E: Eclipsing binary [subgroups: EA - Algol type, EB - Beta Lyr type, EW - W UMa type]
Lb: Slow irregular variables
M: Mira type pulsating variable
N: Nova
NL: Nova-like
UG: U Gem type cataclysmic variable (dwarf nova); UGSS: SS Cyg type; UGSU: SU UMa type; UGZ: Z Cam type; UGWZ: WZ Sge type.
SR: Semi-regular variables
VY: VY Sculptoris variables, not yet recognized within the GCVS but which show occasional drops from steady high states.

The range in magnitudes are all visual except where followed by a “p”, in which case they are photographic or a “B” when it is a blue filter magnitude.

These magnitudes are approximate and are not well-defined for these objects. They should be taken as a guide only.

Explanation of the CCD Target List Categories
(Repeated from VSSC 114 for completeness)

Beginners Category

This category of object comprises bright, fast eclipsing binaries, which are ideal for new CCD observers to monitor, with a view to testing of systems, and checking of initial results.

Basic CCD Data

Projects in this category are designed for CCD observers who want to use their CCD cameras to do useful work, but who are not yet ready to use filters, or to do transformations to convert their magnitudes to a standard system. This means that projects in this category are aimed primarily at the detection of changes, which are too faint for visual observers to routinely monitor, and which will alert other CCD observers to follow these objects.

Precision Timing Data

For projects listed in this category, the emphasis is on obtaining measurements with accurate recording of the time at which the measurements were made. It would also be good practice, and useful in the analysis of the data, if an estimation of the error on the time can be made. No filter is required for these projects.

Approximate Differential Photometry

This category of projects is for those CCD observers who are able to use an appropriate V filter which, when combined with their CCD camera response, puts the derived magnitudes approximately on the standard Kron-Cousins system, without transformations being necessary. Potential observers who would like advice on filter/CCD camera combinations should contact the section CCD advisor. Data from this category, can be combined with that of other observers to build up a useful set of data for analysis. It would be good practice to attempt to estimate the errors of the magnitude and time measurement.

Precision Differential Photometry

This category of work is aimed at the experienced CCD observer who is not only happy to use a filter, but who is also confident at applying the correct transformations to his reduced magnitudes, in order to precisely transform those magnitudes to that of the standard Kron-Cousins system. It would be good practice to include error bars on all measured quantities.

Reasons for Observing these Targets

The Bright Eclipsing Binaries
These systems have been added in this new category, to provide observers with some systems that they might like to observe when first starting out in CCD photometry. These systems are of a well-known magnitude, are reasonably bright and easy to find, and have known periods, enabling thorough testing of a CCD system and reduction techniques, before moving on to the more challenging projects. However, observations to determine the time of minimum will still be of scientific value.

V1363 Cyg
This star has a GCVS classification of UGZ. Observation has shown this to be very unlikely, although it's true nature is as yet unknown with any certainty. There have apparently been only six brief periods when this system has been detected in a bright state since 1993.
There have been suggestions that this system might be a VY Scl-type system, spending time in an faint quiescent state, but also having outbursts with standstill-like features. The aim is to detect V1363 Cyg at minimum, and to detect any rise in brightness over short or long time scales. If it is a VY Scl star, then the current low state may end at some point. If it does show outbursts we can learn how frequent they are, and what amplitude the outbursts are.

V1454 Cyg

Only one outburst of this suspected UGSS class CV has ever been detected (in 1996 at 13.6mv). CCD observations might reveal fainter and more frequent outbursts.

CG Dra

The aim is to monitor outbursts to reveal their approximate amplitude cycle (an <82d cycle has been suggested in IBVS 5124).

V650 Ori

There are no recorded outbursts of this possible UG object which is extremely poorly studied. There has been only one possible CCD observation (in early 1996 at magnitude 18). The aim of this project is to try to image the variable at minimum and to check for faint outbursts outside of the range of visual observers i.e. <16.0.

V402 And, V630 Cas, V336 Per, DV Dra, V358 Lyr, V452 Cas, CI Gem and 1502+09 Boo

These stars are all under-observed faint systems that are likely to be dwarf novae. The aim is to start to learn more about these stars, and to alert other observers to outbursts so that more data can be collected.

ES Dra

This dwarf nova system has an estimated orbital period of 3 hours, but this is only approximate, and needs refining by taking measurements at around a rate of one frame per minute over periods of 3 hours or more. The key issue here, is the detection of possible superhumps and/or eclipse dips (if they exist). A check star trace should be taken and reduced along with ES Dra.

KU Cas

The orbital inclination of this system suggests that it may be an eclipsing star, but this has not been confirmed; it also has an unknown orbital period and is under-observed! It presents a good opportunity for careful work, which should be of the same specification as for ES Dra, but as the orbital period is unknown, the runs should be for as long as possible; it is also worth looking to see if there might be superhumps, the signature of an SU UMa type system.

TZ Per

This Z Cam type CV needs to be examined for the existence of eclipses. Its orbital period is known to be 6.252 hours, therefore long observing runs are required on this object.

NSV2249 – an enigma?

Chris Jones's observations of this Mike Collins star, suggest that this is a Mira. However, during the 2000 apparition it faded from mag 11.7 to mag 15 in 87 days, and during the 2001 apparition it faded from 11.5 to 13.5, in more than 120 days. So are these two data sets in conflict, or is there some other answer? From good CCD images we should be able to determine what the rate of decline of this star really is, and find the minimum magnitude.

Eclipse Time measurements of HU Aqr (15.3-20.0) and HT Cas (10.8-18.4)

This project requires good time resolution with photometry of very faint stars; this is not a project for the faint-hearted! There has been some speculation that eclipse time ephemerides may vary over a period of time. Eclipse ephemerides have been examined for variation over a time period, using occasional measurements from large professional telescopes, but there has been no long term systematic monitoring of these times; this is therefore an ideal project for the more ambitious amateur. Who knows what this work may turn up!

Eclipsing Binary Ephemerides

Two eclipsing binaries, NSV4441Cnc (GO Cnc, mag 8.3-8.8) and NSV 4031 Lyn (8.0-8.8) have no ephemerides, and reduced photometry of these systems would enable them to be calculated. Images should be taken whenever observing conditions permit, together with the time at which the image was taken.

V720 Cas, TAV 0714+17, J0712+296 and TAV 1933+53

These stars are all on the 2005 ICCE programme; this programme exists to answer questions arising regarding either the **I**dentification, **C**haracterisation, or **C**orrection of **E**rroneous GCVS entries for target stars. The identity of V720 Cas is in question, due to the close proximity of three stars, and this work is most suitable for CCD cameras for this reason. All of these four stars are extremely red in colour, and this means that visual observations of these targets exhibit an extremely large scatter, making type determination difficult. Filtered CCD observations over a period of time, would make characterisation possible.

Theoreticians need SS Cyg Observations

Scientists at Leicester University have constructed a theoretical model for an SS Cyg-type system, which predicts that the inner part of the accretion disc only, may sometimes go into outburst; there is a hint that this kind of behaviour may take place in visual observations, but in order to test the models, precision multicolour observations of SS Cyg, taken continuously through the night, over a number of nights (consecutive if possible) are requested. There is most interest in the results that are obtained using a U or a B filter (where the quantum efficiency of the CCD camera will allow), although observers with a filter wheel could take images sequentially through more than one filter, or observers could work together on the same nights, with one using a B filter, and one using a V filter.

Albert and Tim's Period-Luminosity Relationship

Tim Bedding (Univerisity of Sydney, Australia) and Albert Zijlstra (UMIST, Manchester) have recently published their work, in which they use Hipparcos data for a number of Miras and semiregulars that have known periods, and parallaxes measured to better than 20%; they identify period-luminosity sequences for such stars. As distance indicators such stars are far more numerous than Cepheid variables, and the nearer stars have calibrated distances. An understanding of the P-L relationship also provides much information on how these stars pulsate and how they evolve. However, several of the Hipparcos stars that have good parallaxes still have unknown periods. CCD measurements of these stars, leading to an estimation of their periods would provide useful additional data to add to the sequence. The three stars selected below, are such stars. They are extremely bright, and the amplitude variations are very small and may be irregular, so they may need to be monitored for some considerable time. They would be ideal for a CCD camera with a camera lens attached, but the measurements must be made with a V filter, as these stars are very red, and it will be difficult to combine measurements from different systems otherwise. These present a challenge!

- VZ Cam is around V magnitude 4.9, with a variation of < 0.2 magnitudes
- CO UMa is around V magnitude 5.8, with a variation of > 0.2 magnitudes
- AT Dra is around V magnitude 5.5, with a variation of > 0.2 magnitudes

There are many more stars on this list, available to interested observers.

GY Cancri

GY Cnc is a deeply-eclipsing dwarf nova with the potential to reveal in detail how dwarf nova outbursts begin. Accurate, fast (1-4 frames per minute) V-filtered photometry of this system at the beginning of an outburst should aim to cover eclipses or even complete orbital periods of 4.21 hours. A bonus would be parallel V and R or I band measurements. Successful

observations of the evolution of the eclipse profiles up to the outburst maximum would show whether outburst development is inside-out or outside-in; a key question for theoreticians modelling dwarf nova outbursts is whether this direction is correlated with the rise time of the outburst. There is much more detailed information regarding this project in the Variable Star circular number 114, and on the Variable Star web page at
http://www.britastro.org/vss/variable_star_section_ccd_target/gycnc.htm.

Archiving of VS CCD data

It is hoped that the data that is obtained from these projects will help the VS in its ongoing development of its CCD database.

At this stage, it is intended that CCD observers should personally store their raw images, and that they will also keep a personal observing log, a template for which is available on request from David Boyd at drsboyd@dsl.pipex.com (see also VSSC 121). This personal observing log will contain all data pertinent to an evening's observing session, together with reduced magnitudes for their objects of interest. These reduced magnitudes, can then be sent to the VS Section CCD database (again, see VSSC 121 and/or contact the Director for up-to-date information regarding the template and submission of CCD data).

This will allow us to make reduced light curves available eventually, via the web pages, for viewing. If researchers require the raw data for further analysis, then these will be requested from the respective observers.

Summary

The VS CCD Target list provides the opportunity to work on common projects, and to learn about doing good photometry together. A good optical system is not necessary for good photometry, indeed, photometrists frequently defocus their target stars of interest to improve their measurements. What is necessary is the willingness to learn to do careful measurements, and to keep a good record of those measurements.