

High-speed photometry of faint cataclysmic variables – I. V359 Cen, XZ Eri, HY Lup, V351 Pup, V630 Sgr, YY Tel, CQ Vel and CE-315

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ABSTRACT

The first results of a photometric survey of faint cataclysmic variables are presented. V359 Cen is an SU UMa star with a period of 112 min. Even though it is observed at quiescence, the mass-transfer rate in this old nova may be sufficiently high that in such a short period system (with its implied small mass ratio) the disc may be excited into an elliptical shape with the result that the observed brightness modulation gives a superhump period rather than an orbital period. XZ Eri is an eclipsing dwarf nova with an orbital period (P_{orb}) of 88.1 min. HY Lup has only slight variability. V351 Pup, the remnant of Nova Puppis 1991, has $P_{\text{orb}} = 2.837$ h and a light curve that strongly resembles that of the magnetic Nova Cyg 1975. V630 Sgr is the first nova remnant that has both positive superhumps ($P_{\text{sh}} = 2.980$ h) and eclipses ($P_{\text{orb}} = 2.831$ h). The YY Tel identification is somewhat uncertain. The correct identification for CQ Vel is provided from discovery of its flickering activity. The light curve of CE-315, a recently discovered AM CVn star, shows similarities to that of GP Com, with no apparent orbital modulation.

Key words: techniques: photometric – binaries: close – binaries: eclipsing – novae, cataclysmic variables.

1 INTRODUCTION

Cataclysmic variable (CV) stars are a class of interacting close binaries which attract great attention. They enable a quantitative study of the many processes involved in mass transfer through accretions discs or through magnetically channelled accretion. A list of these physical processes, which also occur in many other astrophysical environments, is given in Warner (2000); a review of CVs in general is given in Warner (1995a).

Fewer than 40 CVs have been studied in any great detail (e.g. with Doppler tomography or eclipse deconvolution). These, and the phenomena seen in other CVs, show that no two CVs are exactly alike. The different combinations of masses of primaries and secondaries, temperatures, magnetic field strengths, orbital inclinations and mass-transfer rates (\dot{M}) suffice to produce great variety of behaviour. Much of this variety is already understood in terms of the component physics accompanying the gross differences. The effects of more subtle differences – e.g. original chemical composition of the secondary, effects on the secondary of past nova explosions, compositional and environmental (for instance, irradiation) dependence of disc viscosity – have still to be teased out of the rich observational phenomenology.

Much of the progress in the past two or three decades has come

from the discovery of an ever greater variety of behaviour. There are often conspicuous effects in the longer-term light curves; examples are the ER UMa stars (dwarf novae with outbursts every few days and superoutbursts every few weeks), ‘echo’ outbursts after a superoutburst and continuous small outbursts in the discs of nova-like variables. New phenomena also continue to be found in the ‘close-up’ details; examples are short-period quasi-periodic oscillations (from ~ 2 s in the X-ray flux of SS Cyg in outburst to ~ 1000 s modulations in many high- \dot{M} discs), spiral waves in discs, tilted discs and desynchronization of polars by nova explosions.

Although some of the new phenomena have accompanied the discovery of new CVs (e.g. the $\sim 10^8$ G magnetic fields in AR UMa and V884 Her), most have been discovered in long-known CVs (e.g. TeV gamma rays from AE Aqr and ZZ Cet pulsations in GW Lib). It is clear, therefore, that while the great majority of CVs remain under-observed, new phenomena may remain undiscovered. At a less exotic level, the determination of a significant number of new orbital periods, and in particular the discovery of eclipsing systems, provide objects for more detailed structural studies. With the advent of 8-m class telescopes, such studies can be made even to the 20th magnitude. The ongoing survey, of which this paper presents the first general results, was initiated with this in mind.

The need for such a survey, particularly in the southern hemisphere, which would be capable of succeeding in the crowded fields in the general direction of the Galactic centre where the

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Table 1. Observing log.

Object	Type	Run No.	Date of obs. (start of night)	HJD of first obs. (+2451000.0)	Length (h)	t_{in} (s)	Tel.	$\langle V \rangle$ (mag)
V359 Cen	SU UMa	S6165	29 Dec 2000	908.50289	2.15	30	74-in	18.8
		S6167	30 Dec 2000	909.51368	1.95	30	74-in	18.7
		S6170	1 Jan 2001	911.51125	2.02	30	74-in	18.7
		S6186	20 Feb 2001	961.37008	2.05	30, 60	40-in	18.6
		S6189	21 Feb 2001	962.41615	4.03	60	40-in	18.7
		S6197	25 Feb 2001	966.35024	2.22	60	40-in	18.6
		S6216	18 May 2001	1048.22183	4.02	60	40-in	18.6
XZ Eri	DN	S6156	26 Dec 2000	905.29165	4.02	20, 60	74-in	19.1
		S6158	27 Dec 2000	906.29347	0.36	30	74-in	19.2
		S6163	29 Dec 2000	908.30081	0.65	20, 30	74-in	19.1
HY Lup	NR	S6191	22 Feb 2001	963.47488	3.76	45	40-in	19.6
V351 Pup	NR	S6157	26 Dec 2000	905.47151	3.06	15	74-in	18.9
		S6160	27 Dec 2000	906.45415	3.62	20	74-in	19.1
		S6162	28 Dec 2000	907.43106	3.96	20	74-in	18.9
		S6185	20 Feb 2000	961.27432	1.93	60	40-in	18.8
		S6192	23 Feb 2000	964.26594	1.20	60	40-in	19.0
V630 Sgr	NR	S6124	24 Aug 2000	781.22202	6.72	10	74-in	17.6
		S6126	25 Aug 2000	782.21315	7.15	5	74-in	17.5
		S6128	26 Aug 2000	783.21314	7.16	5, 10	74-in	17.8
		S6130	27 Aug 2000	784.20912	6.15	5, 10	74-in	17.4
YY Tel	SU UMa	S6100	5 Jun 2000	701.36536	1.39	10	74-in	18.6
		S6218	18 May 2001	1048.61265	1.72	30, 60	40-in	18.6
		S6223	21 May 2001	1051.61806	1.57	60	40-in	18.5
		S6231	26 May 2001	1056.64150	1.07	30, 60	74-in	18.6
CQ Vel	NR	S6071	10 Mar 2000	614.26263	4.07	60	74-in	21.1
CE-315	AM CVn	S6209	15 May 2001	1045.35878	4.26	10	40-in	17.6:
		S6212	16 May 2001	1046.25888	6.63	20	40-in	17.6:

Notes: NR=Nova Remnant, DN=Dwarf Nova, t_{in} is the integration time, ‘:’ indicates an uncertain value.

majority of nova remnants reside, was recognized in the early 1990s, and as a result the CV group at the University of Cape Town (UCT) used several years’ equipment funds (in advance) for the purchase of a state-of-the-art CCD detector. The photometer and its software were designed and constructed by Dr D. O’Donoghue, who was a member of the Astronomy Department at UCT at that time. The UCT CCD photometer, completed in 1993, has been extensively used on telescopes at the Sutherland site of the South African Astronomical Observatory. An outline of its functional properties can be found in O’Donoghue (1995) and Koen & O’Donoghue (1995). In the CV group at UCT it was first largely used for observations of well known CVs at higher time resolution or improved signal-to-noise. Its use for a general survey of faint CVs started in 1997, with the almost immediate discovery of the first ZZ Cet (i.e. non-radial) pulsations in the white dwarf primary of the SU UMa type dwarf nova GW Lib (Warner & van Zyl 1998) and the independent discovery of the intermediate polar nature of the nova remnant HZ Pup (see Abbott & Shafter 1997 for detailed description). Follow-up observations of these led to the neglect of the survey for some time, but we are now actively observing faint CVs again. We present here the initial results.

The observations are given in Section 2 and some brief conclusions are given in Section 3.

2 OBSERVATIONS

All observations have been made with the UCT CCD photometer attached either to the 40-in or 74-in reflectors at Sutherland. In order to capture as many photons as possible, ‘white light’ was used, with the result that extinction corrections and magnitude calibrations are only approximate.

The observing log for the stars included in this paper is given in Table 1.

2.1 V359 Centauri

V359 Cen was discovered bright in 1929 April¹ and entered the lists as a probable nova, unconfirmed because no spectra were obtained. There are still no spectra available at minimum light, but in recent years further outbursts to a maximum of $V \sim 13.8$ have been observed at intervals of ~ 1 y, showing the star to be of SU UMa type. The quiescent magnitude given in the Downes, Webbink & Shara (1997) catalogue is 21.0 from J plates, and Munari & Zwitter (1998) gave $V \geq 20.5$ in 1996, but we find $V \sim 18.7$, which is a great deal easier to observe at moderate time resolution. Our 2001 May observation was obtained three weeks

¹Note that Duerbeck (1987) states the year as 1939, and this has been propagated in later literature.

after a superoutburst, but the star had returned to its quiescent brightness.

Our light curves are displayed in Fig. 1 and show a recurrent hump with an amplitude ~ 0.4 – 0.5 mag. Our observations are not distributed adequately to remove aliases; the best determined period from the 2001 February run is 112 min (0.0779 d). The variations of hump profile and their occasional almost triangular shape resemble what is seen in superhumps more closely than orbital modulations, but it is rare to observe superhumps at quiescence – the only well-documented examples are EG Cnc which sustained ‘late’ superhumps for at least 90 d after the 1996 superoutburst (at a time when ‘echo’ normal outbursts were occurring) (Patterson et al. 1998) and AL Com with a persistent superhump as well as an orbital hump at quiescence (Patterson et al. 1996). If what we are seeing is an orbital hump then the inclination of V359 Cen must be $\sim 65^\circ$.

2.2 XZ Eridanus

XZ Eri has been known as a probable dwarf nova for nearly 70 yr (Shapley & Hughes 1934). In recent years, only three outbursts have been detected: 1995 March–April, 1998 January and 1999 February. The first of these reached $V \sim 14.1$ and the others reached $V \sim 14.6$. CCD photometry at quiescence gives $V = 18.7$ (Howell et al. 1991). The rarity and range of the outbursts suggests that they are superoutbursts. Any normal outbursts may have gone unnoticed. There has not been any high-speed photometry during an outburst.

A quiescence spectrum, obtained by Szkody & Howell (1992) shows the Balmer emission and continuum characteristic of a dwarf nova. There is a hint of doubling in the strongest Balmer lines, indicative of a high inclination system. Nearly 4 h of CCD photometry through a V filter at quiescence, with 220-s integration on a 1.8-m telescope, showed a scatter of ~ 1.0 mag and, to quote the authors, no indications of periodic modulation (Howell et al. 1991).

Our observations (Fig. 2) show XZ Eri to be, in brief, a Z Cha lookalike, with the succession of immersions and emersions of the white dwarf and bright spot all quite clear. At $V \sim 19$, we cannot achieve sufficient time resolution to separate these components as clearly as in Z Cha (e.g. Wood et al. 1986). Using our best estimate for the time of mid-eclipse of the white dwarf, we derive the following ephemeris:

$$\text{HJD}_{\min} = 2451905.4419 + 0^d0612 \text{ E.} \quad (1)$$

The short P_{orb} (1.47 h = 88.1 min) implies that XZ Eri will have superhumps when observed in outburst.

2.3 HY Lupi

HY Lup was Nova Lupi 1993, which reached $V \sim 8$ and was moderately fast ($t_2 \sim 15$ d). It is currently at $V \sim 18.9$ and has a resolved ejecta shell (Downes & Duerbeck 2000). No pre-outburst candidate brighter than $V \sim 17$ is detectable (McNaught & Garrard 1993) and it is probable that the remnant has not yet reached its quiescent brightness. No high-speed photometry has been published for this nova remnant.

Our photometry (Fig. 3) shows little evidence for rapid flickering and only slow variations of small amplitude. There is no suggestion of any orbital modulation which would encourage

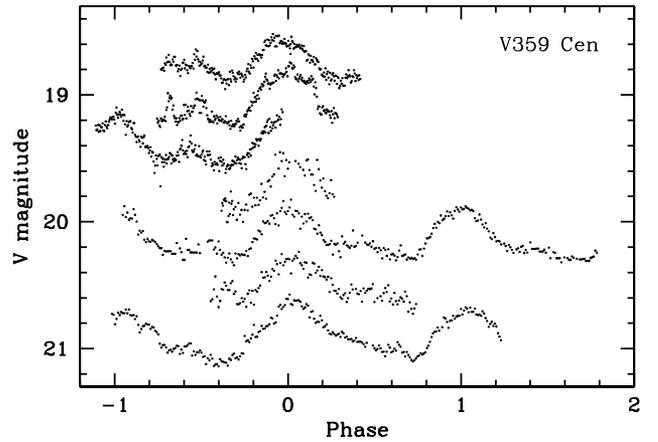


Figure 1. Light curves of V359 Cen at quiescence phased according to the 112-min period. The light curves are plotted from top to bottom in the same order as in Table 1. All light curves, except for the top one, are displaced along the magnitude axis for display purposes only. The mean magnitude of V359 Cen for each run is given in Table 1.

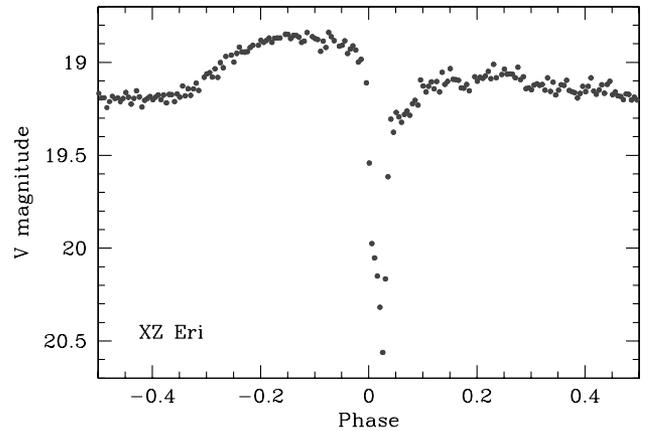


Figure 2. The mean light curve of XZ Eri.

further photometry. The P_{orb} for HY Lup will need to be obtained spectroscopically.

2.4 V351 Puppis

Nova Puppis 1991 (V351 Puppis) was a moderately fast nova ($t_2 = 16$ d), probably a neon nova (Pachoulakis & Saizar 1995). The pre-eruption magnitude was variable over the range 21 to > 22 (McNaught 1992). The eruption light curve through 1996 is illustrated in Saizar et al. (1996); in 1998 the remnant was at $V \sim 19.6$ (Downes & Duerbeck 2000).

There are one or two additional aspects of this nova that are of interest. 16 months after optical maximum, hard X-rays were detected by *ROSAT* which, from the absence of a soft X-ray component, were deduced to be caused either by shocks in the ejected shell or by magnetically controlled accretion on to the white dwarf (Orio et al. 1996). Variability (time-scale $<$ days) observed in the X-ray flux seemed to favour the latter interpretation. However, a later analysis explains the absence of soft X-rays as caused by internal and external absorption, allowing the hard X-rays to be the product of surface nuclear burning, as in most novae (Vanlandingham et al. 2001). Multiwavelength

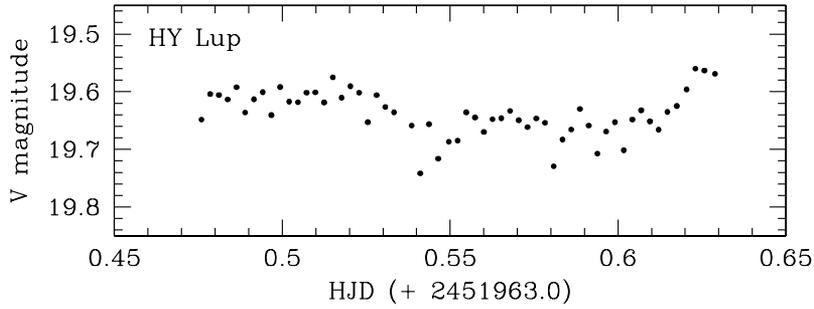


Figure 3. The light curve of HY Lup obtained on 2001 February 22. The data are binned along the horizontal axis by a factor of 5.

observations of the nebular phase of the eruption made in 1992–1993 revealed a strong red excess attributed to the secondary star, implying that this component is either a giant or an irradiated dwarf (Saizar et al. 1996). In the former case an orbital period $P_{\text{orb}} \sim$ days would be expected, in the latter $P_{\text{orb}} \lesssim 4$ h would be required in order for the secondary to be close enough to the hot primary to be strongly irradiated. The relatively small mass of the ejected shell of N Puppis 1991 implies a high mass for the white dwarf – near the Chandrasekhar limit (Vanlandingham et al. 2001).

We observed V351 Pup in 2000 December and found it to be modulated in brightness with a range of up to ~ 1.2 mag and a period of 2.837 h. The light curves are given in Fig. 4 and show variable amplitude, low-amplitude flickering, rounded maxima and a V-shaped minimum which may be filled in to form a flattened region. The ephemeris from these observations is

$$\text{HJD}_{\text{max}} = 2451905.56746 + 0^{\text{d}}1182 \text{ E.} \quad (2)$$

The additional observations we made in 2001 February are too far removed in time to enable us to improve on the precision of the period.

Our light curves for V351 Pup have a striking similarity to those of V1500 Cyg in the late 1980s (see especially fig. 1 of Kaluzny & Chlebowski 1988). V1500 Cyg was Nova Cygni 1975 and in the late 1980s it was about 15.3 mag below its maximum brightness. Nova Pup 1991 was not discovered until after maximum, but there are reasons to believe it did not exceed $V \sim 5.5$ (Saizar et al. 1996) and it therefore at present is ~ 14 mag below maximum. V1500 Cyg is a desynchronised polar (Stockman, Schmidt & Lamb 1988; Kaluzny & Chlebowski 1988) with an orbital period of 3.35 h, which suggests the possibility that V351 Pup may also be magnetic. With this in mind we asked Gary Schmidt to check for circular polarization, and he reports ‘A sequence of spectropolarimetric observations was obtained by G. and P. Schmidt on 2 January 2001 using the 74-in reflector at Mt. Stromlo and covering the range 4220–7300 Å at ~ 10 -Å resolution. The summed spectrum, which spans a total of 3.7 h, reveals a weak continuum ($V \sim 19.4$) that is approximately flat in f_{λ} , plus broad ($\pm 1700 \text{ km s}^{-1}$) nebular emission lines of H, He II and O III. The polarimetric results fail to show significant circular polarization anywhere in the observational sequence, and the coadded sum is unpolarized to a 3σ upper limit of 1 per cent’.

Before dismissing the possibility that V351 Pup is a magnetic nova, we note that (i) the level of circular polarization in V1500 Cyg is ~ 1.5 per cent (Stockman et al. 1988), which, compared with the 10–30 per cent in polars, shows the presence of much unpolarized light, probably that from irradiation of the secondary by the still hot primary; (ii) V351 Pup is 10 yr from its eruption and

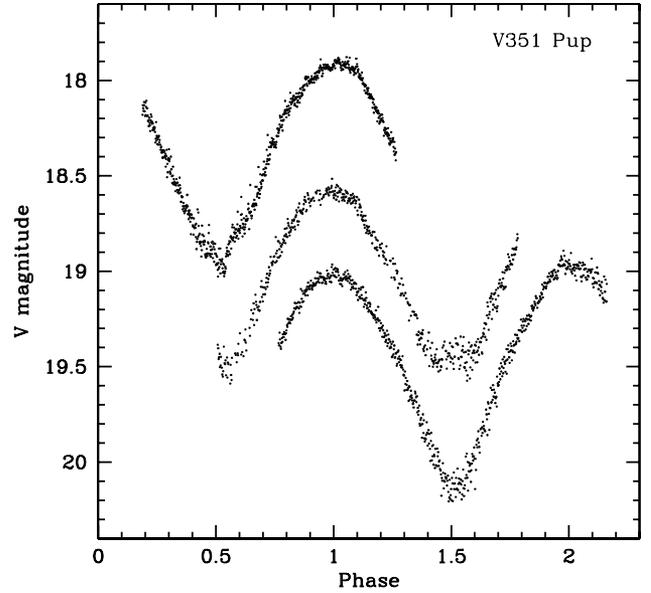


Figure 4. The light curves of V351 Pup obtained in 2000 December, phased according to equation 2. A vertical shift of 0.5 mag has been introduced between light curves for display purposes.

less far in its recovery than V1500 Cyg was in the late 1980s – and should therefore have even more unpolarized light; (iii) GQ Mus (Nova Mus 1983) also has a polar-like orbital light curve and shows strong spectral signatures of magnetic accretion, but no circular polarization (Diaz & Steiner 1994); (iv) similar remarks apply to V2214 Oph (Nova Oph 1988; Baptista et al. 1993).

2.5 V630 Sagittarii

V630 Sgr was the last of four novae detected in Sagittarius in 1936. It was discovered in October of that year, at a time when Harvard objective prism plates were being exposed, whereby it attained the status and alias of HD 321353. The observed maximum was $V \sim 4.5$, but it probably reached $V \sim 1.6$ (Downes et al. 1997), and at minimum it is $V \sim 19$, giving it the unusually large eruption amplitude of ~ 17.5 mag, even for a $t_2 = 4$ d nova, suggesting a high inclination system (Warner 1986; this conclusion arises from the apparent intrinsic faintness of the nearly edge-on accretion disc which such an object has in quiescence).

There have been no modern photometric or spectroscopic observations of V630 Sgr, which is a faint object in a very crowded field. It is listed by Diaz & Steiner (1991), on the basis of its

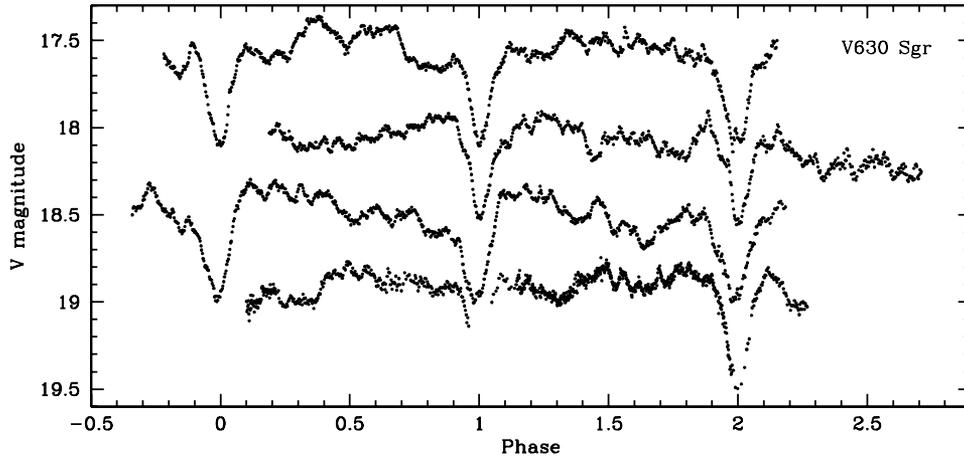


Figure 5. The light curves of V630 Sgr obtained in 2000 August, phased according to equation (3). These have been binned to 30 s to give greater clarity of reproduction. The light curves are plotted from top to bottom in the same order as in Table 1. All light curves, except for the top one, are displaced along the magnitude axis for display purposes only. The mean magnitude of V630 Sgr for each run is given in Table 1.

similarity to V1500 Cyg in being a very fast nova of large amplitude, as a candidate magnetic system.

Our light curves are shown in Fig. 5 and illustrate that V630 Sgr is indeed a moderately high inclination system, with eclipses 0.4–0.6 mag deep. The ephemeris is derived from our light curves, measured from the fundamental Fourier component. The time of the first minimum of our first light curve of this set is given in the ephemeris, which is

$$\text{HJD}_{\min} = 2451781.2480 + 0^{\text{d}}1180 \text{ E.} \quad (3)$$

The orbital period of 2.831 h is just at the top of the orbital period gap.

It is evident from Fig. 5 that there is a hump of complex and variable profile that has a period comparable to P_{orb} . The Fourier amplitude spectrum of the complete set of light curves is shown in Fig. 6. The main groups of power are associated with the fundamental and strong harmonics of the narrow eclipses. The window pattern of the data set can be judged from the first and second harmonics. Superimposed, but slightly offset from the P_{orb} fundamental window pattern, is a second pattern. Prewhitening at the orbital frequency gives a clear pattern with an amplitude of 0.07 mag centred on $P_{\text{sh}} = 2.980 \text{ h}$, which is the period of the drifting humps. Therefore, V630 Sgr is a nova remnant that is also an eclipsing permanent superhumper. This is the first CV found to combine all of these features. The superhump excess of 5.3 per cent and beat period of 2.4 d are typical for superhumps in superoutbursting dwarf novae and novalike variables (Warner 1995a). The beat period is evident in the night-to-night variation of mean brightness, as seen in Fig. 7. The Fourier transform of this delivers an approximate period of 2.1 d and an amplitude of 0.22 mag.

The eclipse depth of $\sim 0.6 \text{ mag}$ is relatively shallow, but at the P_{orb} of V630 Sgr it implies a quite high orbital inclination. The width at half depth of the narrowest eclipses is $\Delta\psi \sim 0.085P_{\text{orb}}$. The secondary mass $M(2)$ at $P_{\text{orb}} = 2.8 \text{ h}$ is $\sim 0.24 M_{\odot}$ (Warner 1995a) and as V630 Sgr was a very fast nova we expect $M(1) \sim 1.2 M_{\odot}$, giving a mass ratio $q \sim 0.20$. These figures are not quite compatible with the theoretical $\Delta\psi$, q , i relationship (Horne 1985), but they serve to show that $i \geq 85^{\circ}$. The presence of superhumps shows V630 Sgr to be a high \dot{M} system which will have a disc radius at the 3:1 resonant radius, which is $r_{\text{d}} = 0.45a$.

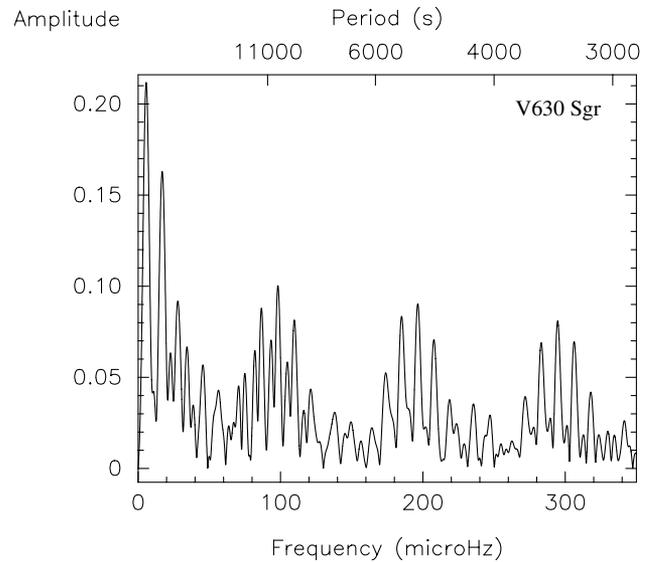


Figure 6. The Fourier transform of the light curves shown in Fig. 5.

The Roche lobe radius for the secondary is $R(2) = 0.25a$ for $q = 0.2$. Therefore, even at large inclination, the eclipses are partial, as is seen in the eclipse profiles in Fig. 5.

The observed eruption range of 17.5 mag is 3.5 mag greater than expected for a $t_2 = 4 \text{ d}$ nova (see fig. 5.4 of Warner 1995a). Using the correction formula (equation 2.63 of Warner 1995a) for disc inclinations removes the 3.5-mag excess if $i \sim 88^{\circ}$. We conclude that V630 Sgr is a very high inclination system.

2.6 YY Telescopium

YY Tel is a dwarf nova with a range $V \sim 14.4\text{--}19.3$ (Downes et al. 1997) suspected to be an SU UMa star of long outburst interval (O’Donoghue et al. 1991). The last reported outburst was in October 1998, and no high-speed photometry has been reported, either in outburst or at quiescence. The candidate identified at quiescence (Downes et al. 1997) was observed spectroscopically by Zwitter & Munari (1996) and showed only a continuum with no emission lines characteristic of a CV. Their photometry gave

$V = 19.26$, $(B - V) = 0.47$ and $(U - B) = -0.28$, placing the candidate near the blackbody line at $T \sim 6700$ K in the two-colour diagram. This is also a region frequented by late F-type subdwarfs.

Our observation on 5 June 2000 showed the YY Tel candidate to be constant in brightness (see Fig. 8). Re-examination nearly one year later again showed absence of any rapid variation but the star changed in brightness by 0.15 mag over three to five days. A nearby, fainter star, marked in Fig. 9 (YY Tel is the brighter of the two stars that are marked), shows marginal evidence for variation and should be examined spectroscopically.

2.7 CQ Velorum

CQ Vel was Nova Velorum 1940, reaching $V \sim 9.0$. It has been identified with a 21st magnitude star (Duerbeck 1987) but no confirmatory spectra or photometry have been obtained. In our observations on 2000 March 10 we found the candidate nova remnant to be of constant brightness as were all the stars in the CCD frame, except for a star slightly fainter than the candidate, 9 arcsec to the north-west (Fig. 10). This star has the flickering characteristic of a CV (see Fig. 11). These observations provide a correct identification for CQ Vel.

2.8 CE-315

CE-315 is a recently discovered member of the AM CVn class of CVs: systems which transfer helium rather than hydrogen (Ruiz et al. 2001). It is only the second of this class to be found in a long-term state of low \dot{M} , the other being GP Com (alias G61-29). Ruiz et al. found a period of 65.1 ± 0.7 min from an S-wave in the spectra, which by analogy with GP Com is thought to be the orbital period.

We have obtained two light curves for CE-315, which are

displayed in Fig. 12. There is no sign in the light curve, or its Fourier transform, of the orbital periodicity. CE-315 resembles GP Com in the general appearance of its light curve (see Warner 1972; Harrop-Allin 1996): much short time-scale flaring or flickering set on a slowly varying background. In GP Com there are occasions when a few cycles at the 46.5-min orbital period appear in the light curve (Harrop-Allin 1996); if the same occurs in CE-315 it would need extensive photometry to detect.

The fact that the two longest-period AM CVn stars, GP Com and CE-315, are low- \dot{M} systems (equivalent to dwarf novae in hydrogen transferring CVs) is in accord with the evolutionary model where orbital angular momentum is the result of radiation of gravitational waves (Warner 1995a,b). According to equation 9.61 of Warner (1995a), the mass-transfer rates should be $\dot{M} \sim 1.0 \times 10^{-11} M_{\odot} \text{y}^{-1}$ for GP Com and $\dot{M} \sim 3 \times 10^{-12} M_{\odot} \text{y}^{-1}$ for CE-315. GP Com has X-rays modulated at the orbital period (Beuermann & Thomas 1993). At $B \sim 17.2$, CE-315 is ~ 1.4 mag fainter than GP Com, but this is accounted for by the lower \dot{M} , so they are at similar distances and it would be worth seeking an X-ray detection.

3 CONCLUSIONS

The results presented here cover a miscellany of CV types and demonstrate the rewards waiting among the fainter members of this class. For those objects where new phenomena have been found (e.g. the possible quiescent superhumps in V359 Cen), or where rarity is an incentive (e.g. the eclipsing superhumping nova remnant V630 Sgr), further observations with larger telescopes are required. V351 Pup may show circular polarization or other magnetic signatures when it has descended the nova light curve further.

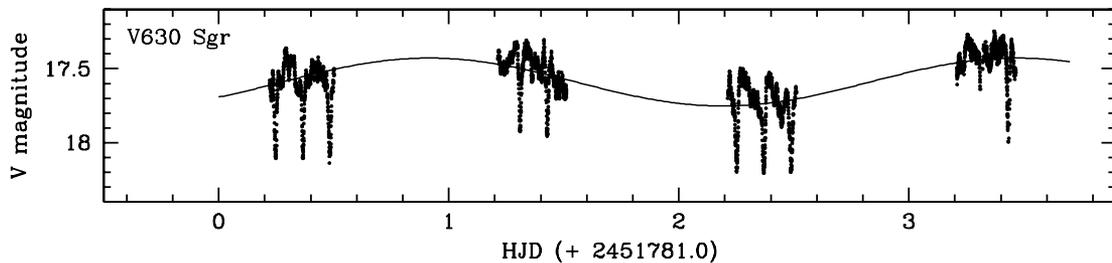


Figure 7. The long-term optical behaviour of V630 Sgr.

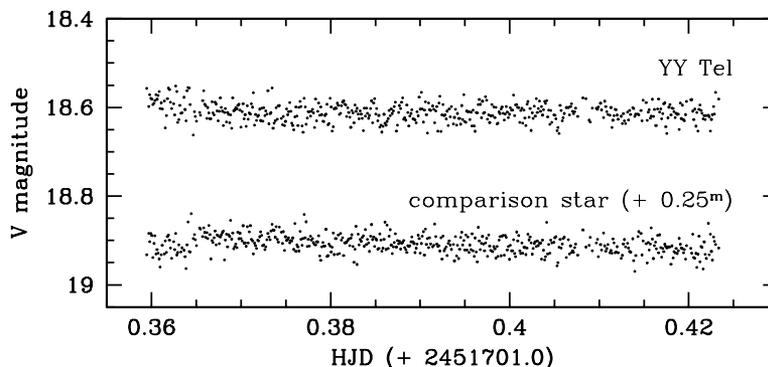


Figure 8. The light curve of YY Tel obtained on 2000 June 6. The lower light curve shows a comparison star of the same brightness (displaced by 0.25 mag for display purposes).

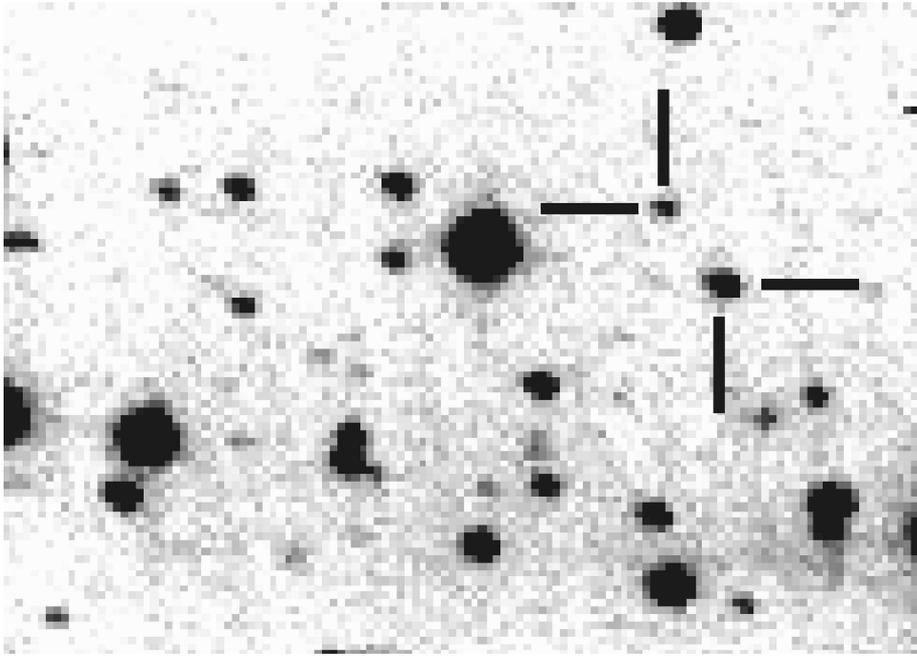


Figure 9. CCD image of YY Tel (the brighter star of the two indicated by markers) taken on 2001 May 21. The field of view is 109 by 74 arcsec, north is up and east is to the left.

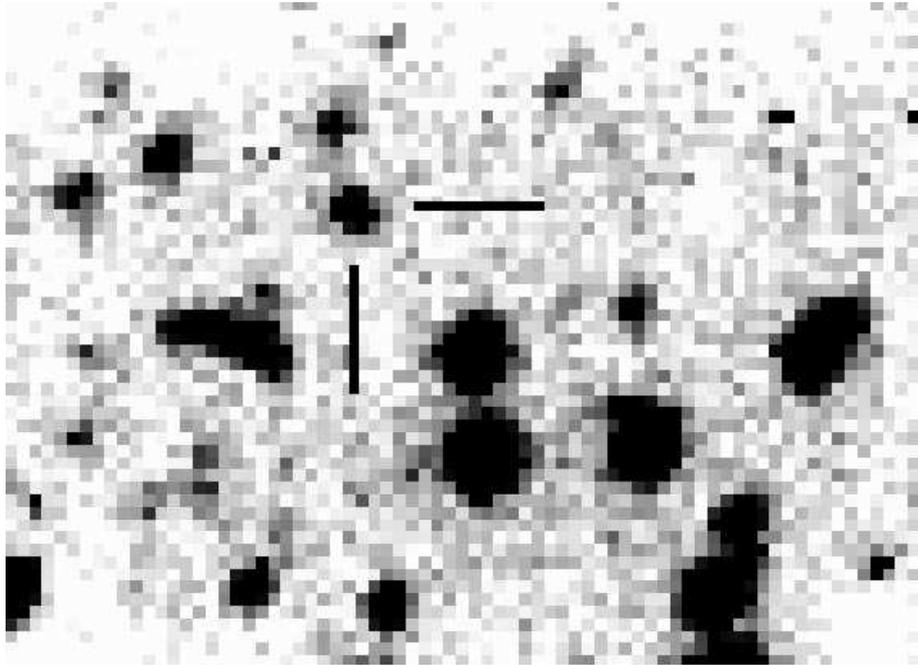


Figure 10. CCD image of CQ Vel (indicated by the markers) taken on 2000 March 10. The field of view is 50 by 34 arcsec, north is up and east is to the left.

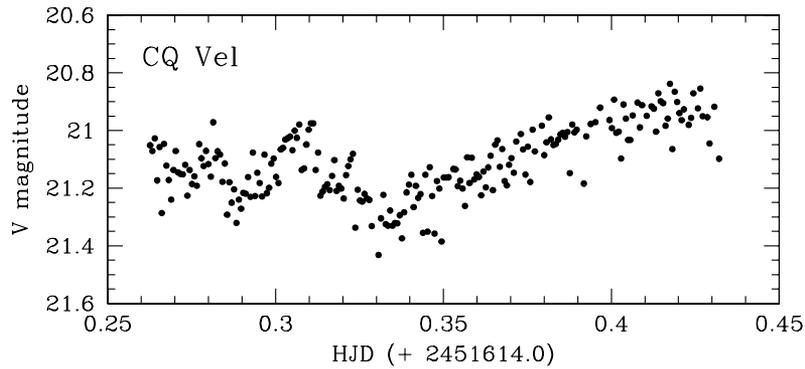


Figure 11. The light curve of CQ Vel ($V = 21.1$) obtained on 2000 March 10.

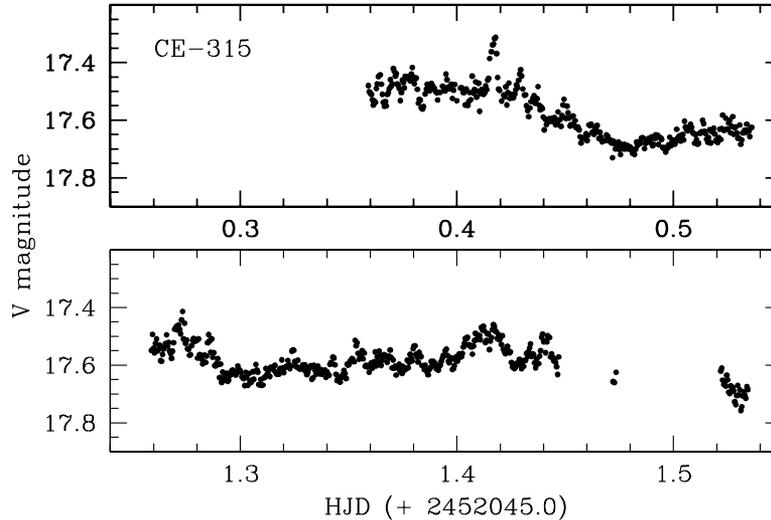


Figure 12. The light curves of CE-315 obtained on 2001 May 15 and 16. The data in the top panel have been binned along the horizontal axis by a factor of four, the data in the bottom panel by a factor of two.

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