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CATACLYSMIC VARIABLES IN THE SUPERBLINK PROPER MOTION SURVEY*

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ABSTRACT

We have discovered a new high proper motion cataclysmic variable (CV) in the SUPERBLINK proper motion survey, which is sensitive to stars with proper motions greater than 40 mas yr^{-1}. This CV was selected for follow-up observations as part of a larger search for CVs selected based on proper motions and their near-UV−V and $V-K_s$ colors. We present spectroscopic observations from the 2.4 m Hiltner Telescope at MDM Observatory. The new CV's orbital period is near 96 minutes, its spectrum shows the double-peaked Balmer emission lines characteristic of quiescent dwarf novae, and its V magnitude is near 18.2. Additionally, we present a full list of known CVs in the SUPERBLINK catalog.

Key words: binaries: close – catalogs – proper motions – solar neighborhood – stars: dwarf novae – surveys

Online-only material: color figure

1. INTRODUCTION

Cataclysmic variable stars (CVs) are close, interacting binaries consisting of a white dwarf and a late-type dwarf star. In these systems, the white dwarf accretes matter from the more extended secondary star through Roche-lobe overflow. Warner (1995) gives a comprehensive review of the field.

Historically, there have been several avenues for the discovery of CVs. The earliest CVs were discovered due to their brightening from an outburst (e.g., Gaposchkin 1957). A few early novae were also discovered due to their emission lines (Fleming & Pickering 1912). Variability remains important to the discovery of new CVs. The Catalina Real-Time Transient Survey (CRTS) repeatedly surveys 26,000 square degrees of the sky (Drake et al. 2009) and has now flagged over 750 objects as "confirmed/likely" CVs discovered solely based on their variability. However, discovery via variability preferentially selects systems that have an observed outburst. Thorstensen & Skinner (2012) show that the CRTS also has a higher discovery rate of systems that have larger outburst amplitude. Other optical variability surveys such as the Mobile Astronomical System of Telescope-Robots (MASTER; Lipunov et al. 2004) and the Automated All-Sky Survey for SuperNovae (ASAS-SN; Shappee et al. 2014) continue to find new CVs through variability.

X-ray emission from CVs is also an important discovery channel. Specifically, the *ROSAT* Bright Survey (RBS; Schwope et al. 2000) contains bright, high Galactic latitude sources ($|b| > 30°$) culled as a flux-limited part of the *ROSAT* All-Sky Survey (Voges et al. 1999). Including the CVs discovered from the deeper *ROSAT* North Ecliptic Pole survey, this produced a flux-limited sample of 20 non-magnetic systems and 30 magnetic systems that were recently used to determine the space density and X-ray luminosity function of CVs (Pretorius et al. 2007, 2013; Pretorius & Knigge 2012).

Another successful avenue for the discovery of CVs relies on targeting emission-line objects or objects with characteristic colors within large optical surveys. 33 CVs were identified from the Palomar–Green Survey (Ringwald 1993), which covered 10,700 deg^2 at high galactic latitude ($|b| > 30°$). The PG survey identified objects based on their UV excess, selecting objects with $U - B < -0.46$ with magnitudes of $B > 16.16$ (Green et al. 1986). The Hamburg Quasar Survey (HQS; Hagen et al. 1995) covered 13,600 deg^2 with the 80 cm Schmidt telescope at Calar Alto. CVs were selected from their broad Balmer emission, their blue color, and variability Gänsicke et al. (2002). This resulted in the identification of 53 new CVs (see Aungwerojwit 2005 for an overview). More recently, numerous CVs have been discovered in the Sloan Digital Sky Survey (SDSS; Szkody et al. 2003, 2004, 2005, 2006, 2007, 2009, 2011; Gänsicke et al. 2009). In particular, Gänsicke et al. (2009) found a number of intrinsically faint systems in SDSS, many of which have periods near the predicted period-minimum spike (Kolb & Baraffe 1999). CVs in SDSS were identified through many methods (Szkody et al. 2002). Photometric selection criteria were developed, but identified far more detached white dwarf–M dwarf binaries (WD+dM). Many CVs were detected because of their overlapping colors with some QSOs that were primary targets in SDSS. Still others were detected in the spectroscopic survey as serendipitous targets. While SDSS has provided the largest and deepest homogeneous sample of CVs to date, it still suffers from selection effects (e.g., Wils et al. 2010; Thorstensen & Skinner 2012).

All of these discovery methods have produced a large sample of CVs to study. However, they all have selection biases and leave out some fraction of the population of CVs. Gänsicke (2005) gives a more complete look at the surveys where CVs have been found and how selection biases have affected each sample. Particularly, the faintest CVs with no known outbursts could easily go unnoticed. Even with the careful work of Pretorius et al. (2007, 2013) and Pretorius & Knigge (2012), the space density of CVs remains uncertain. Ideally, we would like to have a sample of CVs that would

* Based on observations obtained at the MDM Observatory operated by Dartmouth College, Columbia University, The Ohio State University, and the University of Michigan.

Table 1
CVs Discovered due to their Proper Motion

Star	$[\mu_\alpha, \mu_\delta]$ (mas yr^{-1})	Distance (pc)	Discovery Reference
GD 552	125, −40[a]	74(3)[a]	Greenstein & Giclas (1978)
GP Com	−343, +32	68(+7,−6)[b]	Marsh (1999)
V396 Hya	−277, −52	90(+12,−10)[c]	Ruiz et al. (2001b)

[a] J. Thorstensen (2014, private communication)
[b] Thorstensen (2003)
[c] Thorstensen et al. (2008)

enable us to put an upper limit on their space density. By using a survey of stars with large proper motions that is itself complete, we can begin to build a complete sample of the nearest CVs.

A few CVs have been discovered through their high proper motions (see Table 1). GD 552 was discovered in the Lowell Observatory Proper Motion Survey (Giclas et al. 1970) and later identified to be a CV (Greenstein & Giclas 1978) with an orbital period near 103 minutes (Hessman et al. 1984). More recently, Unda-Sanzana et al. (2008) studied this object and suggested GD 552 could have a brown dwarf companion. They also provided evidence that this system is a "period bouncer" (post period minimum CV). GP Com, also discovered in the Lowell Observatory Proper Motion Survey (Giclas et al. 1961), is a double-degenerate helium CV (AM CVn type) with a 46.5 minute period (Marsh 1999). V396 Hya was discovered as a high proper motion star in the Calán-ESO survey (Ruiz et al. 2001b) and is also an AM CVn type system (Ruiz et al. 2001a). With an orbital period near 65 minutes (Thorstensen et al. 2008), it is one of the longest period double degenerate helium CVs known.

This paper presents the first results from our systematic search for nearby CVs in the SUPERBLINK proper motion survey (see Section 2). We concentrate here on a single newly discovered CV, PM I03338+3320, and present a full list of the known CVs in the SUPERBLINK catalog.

2. DISCOVERY

The identification of PM I03338+3320 as a CV was part of a larger project to search for nearby CVs in the SUPERBLINK proper motion survey. Astrometric and photometric properties are provided in Table 2. A finding chart is also provided (Figure 1). SUPERBLINK is an all-sky survey with a proper motion limit of $\mu > 40$ mas yr^{-1}. It is based on an automated search of the Digitized Sky Surveys (DSS) using an image-differencing algorithm, followed by visual examination of candidate objects. A description of the algorithm and quality control practices can be found in Lépine et al. (2002) and Lépine & Shara (2005). New stars with proper motions larger than 450 mas yr^{-1} can be found in Lépine et al. (2002, 2003), and Lépine (2008). A full list of northern sky objects with proper motions larger than 150 mas yr^{-1} can be found in Lépine & Shara (2005), and an all-sky catalog of bright M dwarfs identified in the survey can be found in Lépine & Gaidos (2011). The current SUPERBLINK catalog is estimated to be >90% complete overall and extends to $V \simeq 20.0$. It is more complete at higher galactic latitudes (>95%) where crowding is less of a problem, although the low-latitude completeness is still estimated to be >80%–85%. Analysis is complete for the northern sky, but is ongoing for parts of the southern sky. SUPERBLINK had produced a catalog of 2,270,481 stars as of 2011 July, which is the version we used for the current study.

To isolate CVs in color space, we used the V magnitudes derived from the DSS plates as described in Lépine & Shara (2005), near-UV (NUV) magnitudes from the *Galaxy Evolution Explorer* (*GALEX*; Martin et al. 2005), and K_s magnitudes from the Two Micron All Sky Survey (2MASS; Skrutskie et al. 2006). The top panel of Figure 2 shows PM I03338+3320 within the color cut, as well as the known CVs recovered in SUPERBLINK that have photometry available in all three bands (34 objects; see Table 3). For reference, other stars in SUPERBLINK are shown as gray dots. Visual magnitudes in SUPERBLINK have been derived from the photographic plates of the Palomar Sky Survey (see Lépine & Shara 2005 for a complete explanation). These have a typical uncertainty of 0.5 magnitudes. Our initial color selection, shown as solid lines in both panels, was as follows.

$$\mathrm{NUV} - V < (2.75^*(V - K_s)) - 4.5$$
$$\mathrm{NUV} - V \leqslant 2$$
$$\mathrm{NUV} - V < 10 - (V - K_s).$$

For objects with no previous spectroscopic identification, we have obtained identifying spectra of 99% of objects with declination > −20° and 100% of the northern sky objects with $V < 17.0$ within this color selection (316 objects).

The bottom panel of Figure 2 shows the same region of color space, but highlights two previously discovered CVs that exhibit colors inconsistent with what we would expect for CVs. These objects have V band photometry taken by the CRTS. The arrows in the bottom panel show the revised NUV − V and $V - K_s$ colors based on an estimate of the mean V magnitude from either the Catalina Sky Survey or Siding Spring Survey light curves for these objects. Including these two objects, this initial color selection only includes 47% of the known CVs in SUPERBLINK. In the future, we plan to search the lower values of the $V - K_s$ color for undiscovered CVs.

Table 2
Astrometric and Photometric Properties of PM I03338+3320

α (J2000.0)	δ (J2000.0)	μ (mas yr^{-1})	$[\mu_\alpha, \mu_\delta]$ (mas yr^{-1})	X-Ray (counts s^{-1})	FUV (mag)	NUV (mag)	J (mag)	H (mag)	K_s (mag)	V (mag)
53.469872	33.345783	52	52, −8	⋯	⋯	18.31	16.55	15.90	15.92	18.03

Note. For more detailed information on the quantities listed in this table, see Lépine & Gaidos (2011) and references therein. Proper motion measurements from SUPERBLINK have a typical uncertainty of ± 8 mas yr^{-1}. X-ray flux from the *ROSAT* all-sky point source catalog (Voges et al. 1999). Far- and near-UV photometry from the *GALEX* 5th data release (Martin et al. 2005). *J, H*, and K_s photometry from the 2MASS catalog (Skrutskie et al. 2006). V magnitude determined as outlined in Lépine & Shara (2005).

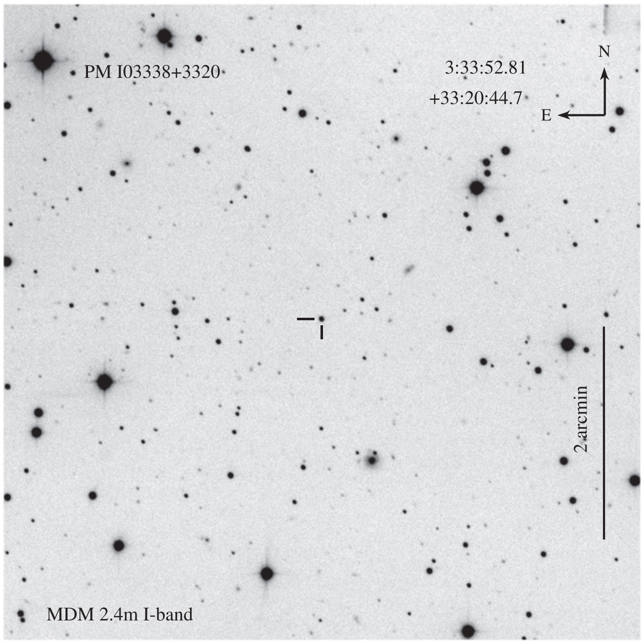

Figure 1. A finding chart for PM I03338+3320 constructed from nine I-band images taken at the 2.4 m Hiltner Telescope in mediocre seeing conditions.

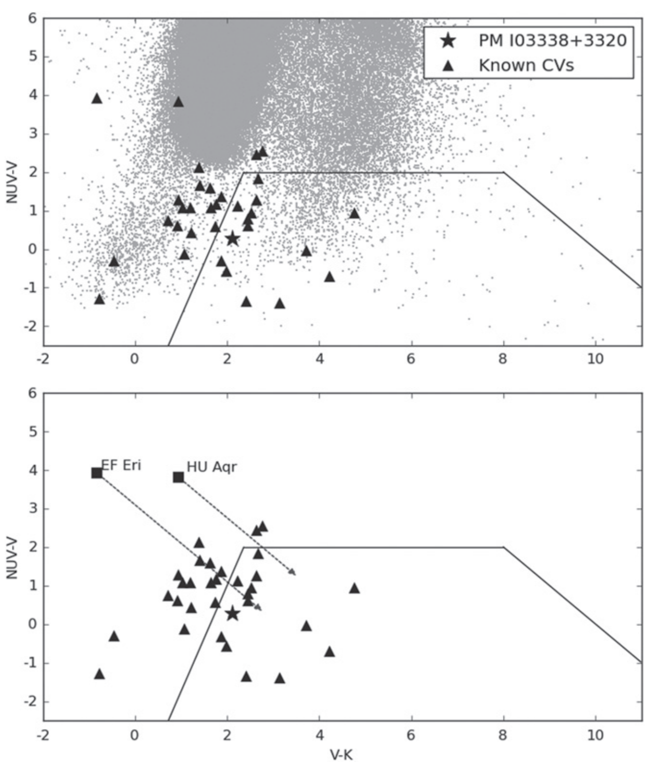

Figure 2. Top panel: we show the position of PM I03338+3320 (solid star) on our color–color diagram along with the recovered known CVs (solid triangles) in SUPERBLINK. For reference, the gray dots show all the objects in SUPERBLINK in this color space. The region shown within the solid lines illustrates our initial color selection used to isolate CVs and related systems. Bottom panel: the two CVs marked as solid squares have *V* magnitudes in SUPERBLINK consistent with being in an outburst or high state. The endpoints of the arrows show their colors using an estimate of the low state *V* magnitude from CRTS (Drake et al. 2009) for EF Eri and HU Aqr.

3. PM I03338+3320: A NEW HIGH PROPER MOTION CV

3.1. Observations

We originally discovered PM I03338+3320 to be a CV in an exploratory spectroscopic run in September 2010 using the OSMOS spectrograph on the 2.4 m Hiltner telescope at MDM observatory. OSMOS (Martini et al. 2011) is a wide field imager and multi-object spectrograph. We used OSMOS in long-slit mode with the volume-phase-holographic grism disperser, which gives a resolution of 2 Å. The center slit yielded a wavelength coverage of 3100–5900 Å, and the inner slit gives a wavelength coverage of 3960–6875 Å.

We obtained follow-up spectroscopy in 2010 November with the same telescope using the modular spectrograph with 2048^2 SITe CCD, which yielded a resolution of 3.5 Å and wavelength coverage from 4210–7520 Å with vignetting toward the ends. Exposures were typically 480 s in good seeing. Wavelength calibrations were done using comparison lamp spectra taken during twilight and shifts derived from the 5577 Å night sky line. Reductions were done using standard IRAF routines except to extract one-dimensional spectra. For this, we used a local implementation (developed by J.T.) of the optimal-extraction algorithm of Horne (1986). All radial velocity measurements were taken with this instrument.

BVRI photometry was taken on 2011 January 24 with the 2.4 m Hiltner telescope and a thick STIS 2048^2 CCD. Landolt standards (Landolt 1992) were used to calibrate. This resulted in a *V* magnitude of 18.2 and provided us with a check of the SUPERBLINK magnitude of $V = 18.03 \pm 0.5$.

3.2. Discussion

The average spectrum shows double peaked emission lines throughout the orbit, but no visible contribution from a secondary star (Figure 3). Emission line velocities from Hα were determined using a convolution method (Schneider & Young 1980; Shafter 1983) that uses an antisymmetric function with positive and negative Gaussians offset by an adjustable separation, α. This is then convolved with the observed line profile and the zero of the convolution is taken as the line center. For PM I03338+3320, we adopted a value of $\alpha = 2284\ \mathrm{km\ s^{-1}}$. We used the "residualgram" method (Thorstensen et al. 1996) to search for P_{orb}. This search (Figure 4) yielded an unambiguous orbital period near 15 cycles per day or 96 minutes. In Figure 5, we plot our best-fit sine curve along with the measured H α emission velocities. The sine curve has the form $v(t) = \gamma + K \sin\left[2\pi\left(t - T_o\right)/P\right]$ and the fit parameters are given in Table 4.

PM I03338+3320 has no observed outbursts despite this region of the sky being monitored closely for transients. In fact, there is a light curve for PM I03338+3320 in CRTS DR1 that shows variability around a mean magnitude of 17.5. This means the CRTS survey should have detected any outburst from PM I03338+3320. In addition, PM I03338+3320 has not been detected in X-ray surveys. These things, along with its relatively faint *V* magnitude, have contributed to it lurking undiscovered until now. Figure 6 shows the UV–optical–IR spectral energy distribution for PM I03338+3320. Extinction corrections were made using E(B-V) from Schlegel et al. (1998) and the York Extinction Solver (McCall 2004) with the galactic extinction law from Fitzpatrick (1999). Of interest is the large amount of flux in the H band, which may suggest a

Table 3
Known CVs Recovered in SUPERBLINK

Name	$[\mu_\alpha, \mu_\delta]$ (mas yr^{-1})	V	NUV − V	V-K_s	In Color selection?	Type	SUPERBLINK ID	Reference
FL Psc	[−69,−18]	16.78	1.09	1.2	n	DN	PM I00251 + 1217	61
J0032-7420	[140,52]	17.84	⋯	5.4	⋯	N-EG	PM I00329−7420	32
EQ Cet	[29,−34]	17.97	1.13	2.23	y	P	PM I01288−2339	49
GZ Cet	[−38,−53]	18.52	⋯	3.22	⋯	DN	PM I01370−0912	38, 56
KT Per	[59,−9]	15.22	⋯	3.49	⋯	DN	PM I01371 + 5057	54
FL Cet	[49,18]	18.62	0.61	2.45	y	P	PM I01557 + 0028	46, 55
PQ And	[38,30]	17.76	⋯	⋯	⋯	DN	PM I02294 + 4002	37
EF Eri	[123,−47]	14.53	3.94	−0.84	y*	P	PM I03142−2235	18
RBS 490	[1,−105]	17.47	0.58	1.73	n	DN	PM I03541−1652	63
IM Eri	[52,−29]	11.92	0.74	0.71	n	NL	PM I04246−2007	7
1RXS J042608.9+354151	[17,−48]	15.86	1.66	1.41	n	DN	PM I04261 + 3541W	10, 23
BF Eri	[28,−109]	15.23	⋯	2.68	⋯	DN	PM I04394−0435	45, 51
IPHAS J0528	[34,−36]	16.46	⋯	1.1	⋯	P	PM I05285 + 2838	3, 69
UW Pic	[28,69]	16.51	1.59	1.62	n	P	PM I05315−4624	41
CSS100114:055843+000626	[14,−41]	19.06	⋯	3.58	⋯	DN	PM I05587 + 0006	13, 64
IR Gem	[52,−21]	15.74	0.44	1.21	n	DN	PM I06475 + 2806	54
PBC J0706.7+0327	[41,−30]	16.34	⋯	1.8	⋯	IP	PM I07068 + 0324	33
U Gem	[−26,−32]	14.54	−0.04	3.71	y	DN	PM I07550 + 2200	23, 25
YZ Cnc	[38,−58]	15.24	−1.35	2.41	y	DN	PM I08109 + 2808E	34
VV Pup	[19,−69]	15.98	⋯	1.44	⋯	P	PM I08151−1903	47, 60
IX Vel	[−27,−96]	9.44	⋯	0.61	⋯	NL	PM I08153−4913	16
LV Cnc	[−53,−4]	17.7	1.01	⋯	⋯	CV	PM I09197 + 0857	57
IY UMa	[−42,−8]	16.61	1.18	1.75	n	DN	PM I10439 + 5807	65
1RXS J105010.3-140431	[−181,−4]	16.76	1.09	1.02	n	DN	PM I10501−1404	29
SX LMi	[22,−34]	16.3	0.62	0.91	n	DN	PM I10545 + 3006W	31, 67
AN UMa	[−41,−20]	16.94	1.37	1.87	n	P	PM I11044 + 4503	26
AR UMa	[−77,2]	16.4	−1.39	3.13	y	P	PM I11157 + 4258	42
RZ Leo	[−42,35]	19.6	−0.69	4.21	y	DN	PM I11373 + 0148	20
SDSS J113826.73+061919.5	[−50,11]	18.17	1.03	⋯	⋯	CV	PM I11384 + 0619	58
QZ Vir	[−99,−44]	15.81	−0.57	1.98	y	DN	PM I11384 + 0322	24
V1040 Cen	[−126,82]	14.13	⋯	1.19	⋯	DN	PM I11554−5641	36
SDSS J121913.04+204938.3	[21,−73]	19.38	0.45	⋯	⋯	CV	PM I12192 + 2049	58
AM CVn	[34,24]	14.19	-0.29	−0.46	n	AC	PM I12349 + 3737	14
V406 Vir	[−135,−36]	18.29	−0.31	1.87	y	DN	PM I12382−0339	56, 71
SDSS J125044.42+154957.3	[−72,−59]	18.28	0.94	2.52	y	P	PM I12507 + 1549	5
GP Com	[−333,47]	16.22	−0.12	1.07	n	AC	PM I13057 + 1801	28, 30
V396 Hya	[−257,−22]	18.26	0.49	⋯	⋯	AC	PM I13127−2321N	43
UX UMa	[−41,16]	13.19	1.28	0.93	n	NL	PM I13366 + 5154	68
SDSS J141118.31+481257.6	[−31,35]	19.37	0.11	⋯	⋯	AC	PM I14113 + 4812	2
SDSS J143317.78+101123.3	[−2,−55]	18.86	0.47	⋯	⋯	DN	PM I14332 + 1011	27
NZ Boo	[−78,−31]	17.59	0.79	2.44	y	DN	PM I15026 + 3334	58, 27
OV Boo	[−146,54]	18.61	−0.12	⋯	⋯	CV	PM I15073 + 5230	66
PP Boo	[−59,−23]	19.45	1.04	⋯	⋯	CV	PM I15142 + 4549	11
SDSS J152212+0803	[−58,18]	15.89	⋯	2.04	⋯	CV	PM I15222 + 0803W	59
SDSS J152419.33+220920.0	[−44,23]	19.32	0.86	⋯	⋯	DN	PM I15243 + 2209	22, 59
MLS120517:152507-032655	[15,−55]	18.22	1.83	2.67	y	CV	PM I15251−0326	13
V2051 Oph	[−18,−58]	15.07	⋯	⋯	⋯	DN	PM I17083−2548S	4
EX Dra	[41,8]	14.7	2.45	2.64	n	DN	PM I18042 + 6754	15
AM Her	[−43,23]	13.63	1.27	2.63	y	P	PM I18162 + 4952	8, 39, 53, 60
KIS J192703.08+421131.7	[49,80]	19.05	⋯	⋯	⋯	CV	PM I19270 + 4211	44
V3885 Sgr	[30,−40]	10.33	⋯	0.71	⋯	NL	PM I19476−4200	9
V503 Cyg	[−18,−48]	15.83	⋯	0.63	⋯	DN	PM I20272 + 4341	19
AE Aqr	[71,15]	11.54	2.56	2.77	n	IP	PM I20401−0052	21
HU Aqr	[−72,−42]	14.56	3.83	0.93	y*	P	PM I21079−0517	48
VY Aqr	[34,−32]	16.23	1.08	1.64	n	DN	PM I21121−0849	35
SS Cyg	[107,30]	11.69	⋯	3.39	⋯	DN	PM I21427 + 4335	6
RX J2237.5+0827	[−92,−44]	15.55	−1.27	−0.77	n	CV:	PM I22375 + 0828	1, 12
V367 Peg	[39,−20]	18.38	⋯	2.93	⋯	DN	PM I22450 + 1655	70
2XMMiJ225036.9+573154	[53,30]	19.46	⋯	⋯	⋯	P	PM I22506 + 5731	40
GD 552	[114,−39]	16.47	⋯	2.01	⋯	DN	PM I22506 + 6328	17
V405 Peg	[−40,−53]	16.56	0.95	4.75	y	DN	PM I23098 + 2135	50

Table 3
(Continued)

Name	$[\mu_\alpha, \mu_\delta]$ (mas yr^{-1})	V	NUV − V	V-K_s	In Color selection?	Type	SUPERBLINK ID	Reference
EI Psc	[−40,39]	15.48	2.12	1.38	n	DN	PM I23299 + 0628	52, 62

Note. V magnitudes from the SUPERBLINK catalog and have a typical uncertainty of 0.5 mag (see the text). EF Eri and HU Aqr have been included in the color selection based on their photometry from CRTS. This is indicated by an asterisk next to their color selection status in column 6. To the best of our ability, discovery and type references have been quoted for each object. In the case of systems discovered in the past ~25 years, this is straightforward. For long-studied, well-known systems, these references become harder to pinpoint. In some cases, we have referenced a more modern paper that gives the history of the study of the object. Type abbreviations: AC—AM CVn, CV—unclassified, DN—Dwarf Nova, EG—extragalactic, IP—Intermediate Polar, N—Nova, NL—Nova-like variable, P—Polar; A colon indicates uncertainty in classification.

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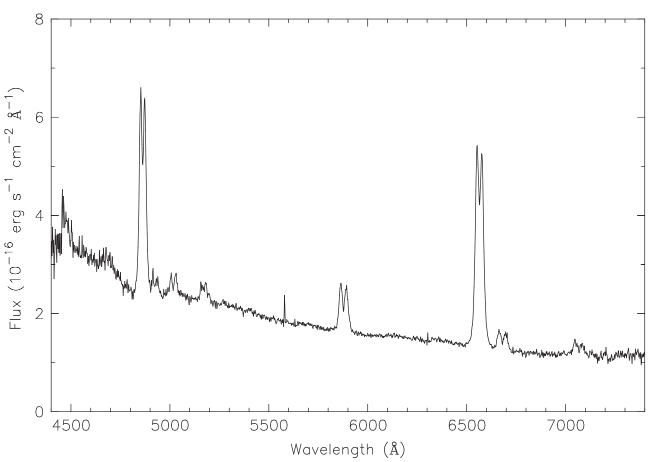

Figure 3. The mean spectrum of PM I03338+3320, which shows double-peaked emission lines. There is no visible contribution from a secondary.

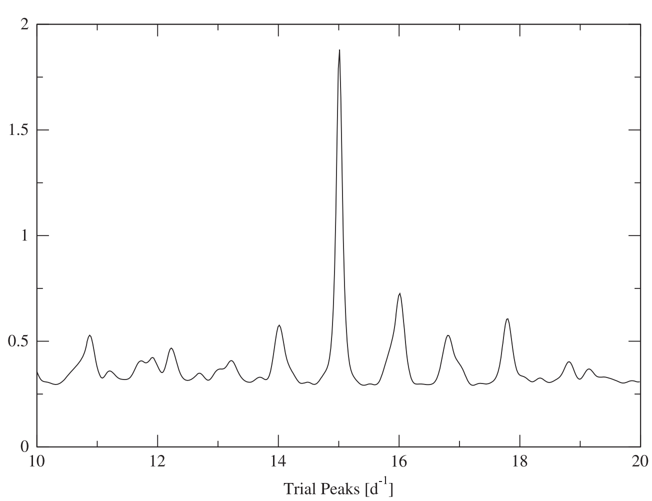

Figure 4. The periodogram showing part of the range of periods tested. The peak around 15 cycles per day stands out clearly as the best fit orbital period.

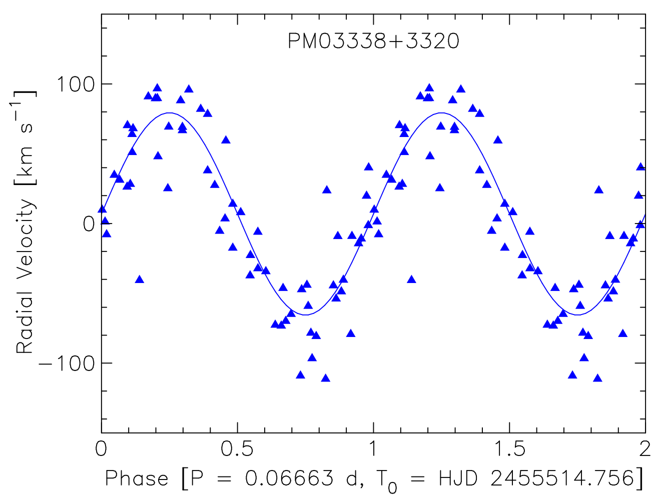

Figure 5. Velocities from Hα are shown by filled triangles along with the best-fit sinusoid as a solid line. The velocities are repeated for a second cycle for clarity.

(A color version of this figure is available in the online journal.)

very late-type companion. Near-IR spectroscopy of this object would be useful to determine the nature of the secondary star.

4. CONCLUSION

The identification of the high proper motion star PM I03338 +3320 as a CV is evidence that there is a portion of the nearby CV population yet to be discovered. Our color selection method proves to be promising with this discovery, but future work needs to be done probing bluer values of V-K_s to develop a clear picture of the nearby population of CVs. PM I03338 +3320 is one of very few CVs to be discovered because of its high proper motion. It has an orbital period of 0.06663 days with a spectrum that shows the double peaked spectral lines indicative of quiescent dwarf novae. Its orbital period and lack of observed outburst make it a likely SU UMa-type star. The

Table 4
Sinusoidal Fit

Data Set	Epoch (days)	Period (days)	K (km s^{-1})	γ (km s^{-1})	σ (km s^{-1})	N
Hα emission	55514.7558(10)	0.06663(7)	73(7)	7(5)	64	22

Note. K is the amplitude of the sinusoidal fit, γ is the mean velocity, and σ is the error in a single measure based on the scatter around the best fit.

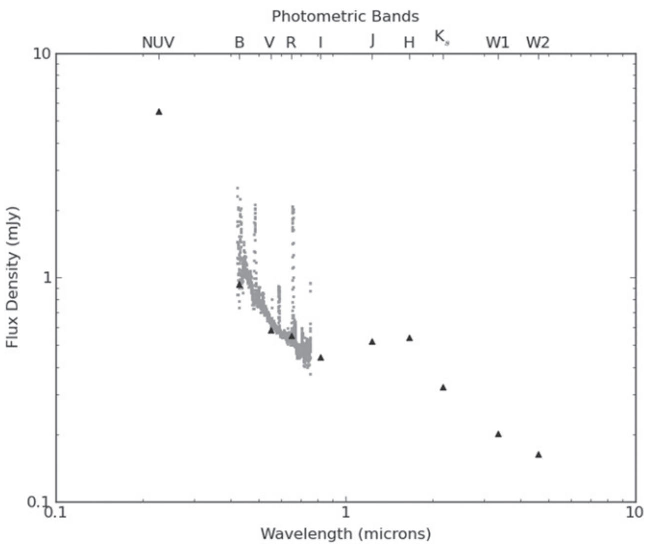

Figure 6. Dereddened UV–optical–IR spectral energy distribution of PM I03338+3320 is shown. The gray dots show the flux density from our mean spectrum. The black triangles show the flux density in the corresponding photometric band shown on the top axis of the plot.

collection of known CVs from SUPERBLINK presented here also gives us a large sample of systems with accurate proper motions to further help characterize the intrinsic population of CVs.

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