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CATACLYSMIC VARIABLES FROM SDSS. VII. THE SEVENTH YEAR (2006)*

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ABSTRACT

Coordinates, magnitudes, and spectra are presented for 39 cataclysmic variables (CVs) found in Sloan Digital Sky Survey (SDSS) spectra that were primarily obtained in 2006. Of these, 13 were CVs identified prior to the SDSS spectra (AK Cnc, GY Cnc, GO Com, ST LMi, NY Ser, MR Ser, QW Ser, EU UMa, IY UMa, HS1340+1524, RXJ1610.1+0352, Boo 1, Leo 5). Follow-up spectroscopic observations of seven systems (including one from year 2005 and another from year 2004) were obtained, resulting in estimates of the orbital periods for three objects. The new CVs include two candidates for high inclination, eclipsing systems, four new polars, and three systems whose spectra clearly reveal atmospheric absorption lines from the underlying white dwarf.

Key words: binaries: eclipsing – binaries: spectroscopic – novae, cataclysmic variables – stars: dwarf novae

1. INTRODUCTION

The sixth data release from the Sloan Digital Sky Survey (SDSS; York et al. 2000) presented the complete photometry of the Galactic cap as well as further spectroscopy with improved calibrations (Adelman-McCarthy et al. 2008). Previous releases are detailed by Stoughton et al. (2002), Abazajian et al. (2003, 2004, 2005), and Adelman-McCarthy et al. (2006, 2007).[8] This paper continues the series of identification of cataclysmic variables (CVs) from the available spectra, with each paper comprising the objects found in spectra obtained in a given calendar year (Szkody et al. 2002, 2003, 2004, 2005, 2006, 2007; Papers I–VI). The results for the CVs found in plates obtained in 2006 are presented here. These objects include dwarf novae, novalike systems, and systems containing highly magnetic white dwarfs (a comprehensive review of all the various kinds of CVs is contained in Warner 1995). The number of CVs found in SDSS now constitutes a significant sample of uniform (in resolution and wavelength coverage) spectra for over 200 objects, and population studies and implications of the results for different types of CVs are emerging (Schmidt et al. 2005; Gänsicke et al. 2009). While the SDSS is not a targeted CV survey and not all objects in the photometric sky coverage have spectra obtained to find CVs, Gänsicke et al. (2009) compare the SDSS sample with the past Palomar Green and Hamburg Quasar Surveys and consider selection effects. They conclude that the primary advantages of SDSS lie in its great depth and the large amount of spectroscopic follow-up of candidates. The increased depth results in a significant difference in the period distribution found from the SDSS sample of CVs compared to these previous (brighter) surveys in that the majority of the SDSS CVs are found at periods below 2 hr and there is an overabundance of systems at periods between 80 and 86 minutes. This distribution and period spike follow the predictions of CV evolution models more closely than past surveys.

The above results stem from concentrated efforts by many people in the community to obtain follow-up photometry and spectroscopy in order to determine the orbital periods and characteristics of the CVs in the SDSS database (Gänsicke et al. 2009 summarize available results for 116, almost half of the total number). Our brief descriptions of the spectra and our few follow-up observations are intended to aid these follow-up studies.

2. OBSERVATIONS AND REDUCTIONS

Detailed information about the SDSS survey (Pier et al. 2003; Gunn et al. 1998, 2006; Lupton et al. 1999, 2001; Hogg et al. 2001; Ivezic et al. 2004; Tucker et al. 2006; Fukugita et al. 1996; Smith et al. 2002; Padmanabhan et al. 2008) and how the CVs are found (Szkody et al. 2002) from the selection algorithms (Stoughton et al. 2002; Richards et al. 2002) already exist in the literature. It is important to keep in mind that objects in the imaging data are chosen for spectra from colors that match criteria selected by various working groups. CVs are primarily found that match colors of quasar, serendipity, and white dwarf groups, as the CVs can be blue if they contain a thick disk, red if they contain a polar, and both red and blue if the disk is thin and the individual stars are viewed (typical colors of the CVs found in SDSS are plotted in color–color diagrams shown in Papers I and II). While Table 1 shows that the CVs that do have spectra encompass a wide range of colors, this does not guarantee that all the CVs in the imaging area covered have spectra obtained.

The search of all spectral plates that are obtained is accomplished via a software program that selects all objects with Balmer emission/absorption lines and the selected spectra are visually examined. All the spectra on a few plates were visually examined to evaluate the effectiveness of the selection algorithm. While a few are missed if they are very faint or they are

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* Based on observations obtained with the Sloan Digital Sky Survey and with the Apache Point Observatory (APO) 3.5 m telescope, which are owned and operated by the Astrophysical Research Consortium (ARC).

[8] Data are available from http://www.sdss.org

Table 1
CVs in SDSS

SDSSJ	MJD-P-F[a]	g	$u-g$	$g-r$	$r-i$	$i-z$	P (hr)	Comments[b]
023003.79+260440.3	53764-2399-405	19.91	0.29	0.72	0.60	0.43	. . .	
075808.81+104345.5	53794-2418-278	16.96	0.14	−0.13	−0.10	−0.07	. . .	
082253.12+231300.6	53317-1926-544	21.84	0.76	1.93	0.65	0.31	. . .	
085521.18+111815.0	54085-2575-318	18.81	0.13	0.06	0.15	0.31	1.56	AK Cnc
090113.51+144704.6	53826-2434-400	16.14	0.21	−0.02	−0.07	−0.07	. . .	
090950.53+184947.3	53687-2285-030	16.05	−0.13	0.34	0.39	0.31	4.21	GY Cnc
091001.63+164820.0	53828-2435-075	18.87	−0.34	0.30	0.01	0.22	. . .	
092122.84+203857.1	53708-2289-316	19.85	0.79	0.68	−0.01	−0.35	>1.5	Polar
093537.46+161950.8	54085-2581-332	19.10	0.42	0.08	−0.01	−0.01	. . .	He II
093839.25+534403.8	53764-2404-414	19.15	0.94	0.31	0.19	0.02	. . .	He II
100515.38+191107.9	53768-2372-473	18.22	−0.07	−0.05	0.15	0.26	1.9	DN
102800.08+214813.5	53741-2366-072	16.06	0.37	−0.07	−0.10	−0.09	. . .	1H1025+220 Leo 5
103100.55+202832.2	53770-2375-636	18.26	0.09	−0.28	−0.36	0.15	1.37	Polar
104356.72+580731.9	52427-0949-0358	17.52	0.18	−0.10	0.02	0.45	1.77	IY UMa
105443.06+285032.7	53800-2359-497	19.23	−0.32	−0.49	−0.15	0.14	. . .	
105754.25+275947.5	53800-2359-102	19.90	−0.30	0.27	−0.18	0.16	. . .	
105905.07+272755.5	53800-2359-051	22.09	1.27	1.84	0.35	1.05	>3	Polar
110539.76+250628.6	53789-2212-201	17.63	0.39	0.04	0.57	0.76	1.90	ST LMi Polar
114955.69+284507.3	53799-2222-010	17.63	−0.05	−0.06	−0.11	0.27	1.50	EU UMa Polar
124417.89+300401.0	53828-2237-560	18.61	−0.03	0.10	0.10	0.27	. . .	
125637.10+263643.2	53823-2240-092	17.98	0.06	0.07	0.02	0.18	1.58	GO Com
133309.19+143706.9	53847-1775-428	18.50	0.57	0.36	0.18	0.03	2.2	Polar
134323.16+150916.8	53858-1776-576	17.34	−0.36	0.18	0.04	0.06	1.54	HS1340+1524
150441.76+084752.6	53883-1717-260	19.14	−0.54	−0.02	0.06	0.35	. . .	Boo 1
151302.29+231508.4	53820-2155-163	16.09	0.16	−0.13	−0.04	−0.03	2.35	NY Ser
152212.20+080340.9	53857-1721-209	18.42	−0.14	−0.02	0.02	0.15	. . .	
152419.33+220920.0	53878-2161-189	19.04	−0.03	0.16	0.09	0.31	. . .	
152613.96+081802.3	53857-1721-021	17.79	0.00	−0.02	0.13	0.29	1.79	QW Ser
153015.04+094946.3	53852-1722-141	18.90	−0.49	0.41	0.02	−0.06	. . .	
154453.60+255348.8	53846-1849-074	16.60	−0.13	0.46	0.15	0.34	. . .	
154953.41+173939.0	53875-2170-276	19.44	0.31	0.39	0.18	0.01	. . .	
155247.18+185629.1	53875-2170-441	17.21	0.21	−0.11	0.29	0.69	1.89	MR Ser Polar
155720.75+180720.2	53875-2170-588	18.70	−0.58	0.22	0.15	0.10	2.1	. . .
160419.02+161548.5	53875-2200-292	19.09	−0.37	0.26	0.07	0.05	. . .	
160501.35+203056.9	53793-2205-247	19.89	−0.10	0.01	−0.07	−0.17	. . .	
160932.67+055044.6	53886-1823-411	18.77	0.12	−0.07	−0.10	−0.04	. . .	
161007.50+035232.7	53886-1823-092	17.36	−0.25	0.15	0.41	0.47	3.18	Polar
161909.10+135145.5	53881-2530-327	18.49	0.43	0.68	0.39	0.27	. . .	DN
162718.39+120435.0	53881-2530-068	19.22	−0.23	0.17	0.23	0.37	2.61[c]	DN

Notes.
[a] MJD-Plate-Fiber for spectra; MJD = JD −2,400,000.5.
[b] DN is a dwarf nova.
[c] Superhump period.

misidentified, we estimate that the software finds about 90% of the existing CVs. Table 1 lists the CVs found in SDSS spectra from 2006 January 1 to December 31, with the plate, fiber, and modified Julian date (MJD) of each spectrum. There are also a few objects that were missed in previous years and later recovered. The coordinates are given as equinox J2000.0, with the IAU convention of truncation rather than rounding at the last decimal, and the coordinates have an astrometric accuracy of 0.″10. Photometric magnitudes and colors are from the point-spread function (PSF) photometry and there is no correction for interstellar reddening. For ease of reference, we will hereafter refer to the objects as SDSSJhhmm (hours and minutes of R.A.).

For a few objects, we were able to accomplish follow-up spectroscopy with the APO 3.5 m telescope, using the Dual Imaging Spectrograph (DIS) with the high-resolution gratings (resolution about 2 Å) with a 1.″5 slit (Table 2). Two of these follow-up objects are from CVs found in previous papers (SDSSJ0812 from Paper V and SDSSJ1006 from Paper VI). The spectra were obtained over several hours and were used to construct radial velocity curves. Calibration for flux and wavelength, as well as measurements of the lines were

Table 2
APO Follow-up Spectroscopy

SDSSJ	UT Date	Time (UT)	Exp (s)	Spectra
1549	2006 Jun 17	04:21–06:56	600	14
0812[a]	2006 Oct 22	08:55–12:26	600	17
1005	2007 Apr 20	03:18–05:54	600	14
1619	2007 May 10	04:43–06:43	600	11
1006[b]	2007 May 10	02:48–04:31	600	09
1557	2007 Jul 19	03:43–06:24	600	14
0938	2008 Jan 16	05:56–07:10	600	07

Notes.
[a] Object discovered in Paper V.
[b] Object discovered in Paper VI.

Table 3
SDSS Emission Line Fluxes and Equivalent Widths[a]

SDSSJ	Hβ		Hα		He 4471		He II 4686	
	F	EW	F	EW	F	EW	F	EW
0238	2.6	65	4.4	74	0.7	16	...	...
0758	2.3	4	3.2	10	...	...	...	...
0822	...	...	0.8	25	...	...	...	...
0855	4.0	31	5.5	72	...	...	...	...
0901	2.1	2	3.4	4	...	...	...	...
0909	74.6	57	108.0	85	13.6	11	5.5	4
0910	8.7	89	10.2	154	1.7	17	...	...
0921	1.6	15	1.4	17	0.6	6	0.4	4
0935	0.6	4	1.2	16	...	...	1.1	7
0938	2.1	18	2.8	29	0.7	7	1.5	13
1005	7.5	45	10.4	94	1.1	4	...	...
1028	5.4	5	9.4	14	...	...	0.6	1
1031	...	...	0.3	6	...	...	...	...
1043	3.7	7	9.9	35	...	...	...	...
1054	0.1	2	0.2	7	...	...	...	...
1057	1.1	22	2.6	95	...	...	...	...
1059	...	...	4.0	2	...	...	...	...
1105	3.2	9	0.7	3	...	...	...	...
1149	0.1	1	0.4	7	...	...	...	...
1244	12.0	85	13.1	115	2.4	15	...	...
1256	37.4	101	35.1	124	6.5	15	4.9	13
1333	1.6	150	1.2	107	0.3	19	1.0	77
1343	20.0	71	21.2	100	4.2	14	1.7	6
1504	12.3	114	12.5	165	2.7	22	0.6	5
1513	1.0	9	1.6	20	...	...	...	...
1522	7.1	108	8.7	182	1.5	22	0.9	14
1524	3.6	59	5.1	123	...	...	...	...
1526	...	...	...	...	...	...	...	...
1530	5.3	56	4.9	70	1.3	13	0.6	7
1544	34.8	65	46.7	77	11.1	21	5.1	10
1549	0.9	2	1.8	6	...	...	5.5	10
1552	60.5	27	78.5	33	26.2	12	33.8	16
1557	13.4	64	11.3	71	3.0	12	1.4	6
1604	5.2	63	5.5	97	1.2	14	...	...
1605	1.1	19	2.3	78	...	...	...	...
1609	0.7	12	1.1	36	...	...	...	...
1610	46.5	35	36.8	27	11.3	9	31.0	25
1619	7.3	27	8.8	33	1.1	4	...	...
1627	7.5	83	7.1	94	2.7	28	1.7	19

Note. [a] Fluxes are in units of 10^{-15} erg cm^{-2} s^{-1}, equivalent widths are in units of Å

accomplished with standard IRAF[9] routines. The SDSS spectra were measured with the centroid-finding "e" routine in the IRAF *splot* package to obtain the equivalent widths and fluxes for the Balmer and helium emission lines (Table 3). For the radial velocity curves, a least-squares fit of a sine curve to the velocities was used to find γ (systemic velocity), K (semi-amplitude), P (orbital period), and T_0 (the epoch of red to blue crossing of the systemic velocity); the results are given in Table 4. Note that due to the short time baseline of the data, the periods are only estimates (with about 10% accuracy) and will need several nights of further data for better determinations. Our measurements, however, provide a starting point as to whether systems have short or long periods.

Table 4
Radial Velocity Solutions

SDSSJ	Line	P (minutes)[a]	γ	K (km s^{-1})	T_0 (JD2,454,000+)	σ
0812	Hα	229	−30 ± 1	208 ± 11	30.989	27
0812	Hβ	215	−38 ± 1	172 ± 13	30.988	35
1005	Hα	112	42 ± 1	19 ± 4	210.658	10
1005	Hβ	114	38 ± 1	27 ± 3	210.663	7
1557	Hα	122	−50 ± 3	89 ± 13	300.720	34
1557	Hβ	133	−43 ± 2	117 ± 13	300.727	33

Note. [a]Periods are generally uncertain by 10%, as evidenced by the dispersion between values obtained from the two lines.

3. RESULTS

The SDSS spectra for the 39 systems are shown in Figure 1 and the equivalent widths and fluxes of the prominent hydrogen Balmer and helium emission lines are listed in Table 3. A summary of the various categories of objects is given below.

3.1. Previously Known Systems

Of the 39 entries in Table 1, 13 are CVs that were found prior to SDSS spectra. These include the novalike Leo5 (1H1025+220; SDSSJ1029) and eight dwarf novae: Boo1 (SDSSJ1504), AK Cnc (SDSSJ0855), GY Cnc (SDSSJ0909), GO Com (SDSSJ1256), NY Ser (SDSSJ1513), QW Ser (SDSSJ1526), IY UMa (SDSSJ1043), and HS1340+1524 (SDSSJ1343). Leo5 was previously identified as a CV candidate during the follow-up of HEAO-1 sources, and spectroscopically confirmed by Munari & Zwitter (1998). Boo1 was discovered as a faint emission line star by Filippenko et al. (1985), who tentatively classified the object as a dwarf nova, even though no outburst was observed, and no follow-up observations have been obtained so far. AK Cnc was determined to be a dwarf novae by Wenzel (1993) with an orbital period of 97.3 mm determined by Arenas & Mennickent (1998). GY Cnc was identified as an eclipsing dwarf nova with $P_{\rm orb} = 252.6$ minutes; an updated ephemeris is given by Feline et al. (2005). GO Com has been long known as a dwarf nova (Brun & Petit 1957), and had $P_{\rm orb} = 95$ minutes determined by Howell et al. (1995b). NY Ser was identified as a CV in the Palomar-Green Survey (Green et al. 1986), and a short outburst cycle was noted by Iida et al. (1995). Nogami et al. (1998) measured a superhump period of 153 minutes, making NY Ser the first SU UMa type dwarf nova in the period gap between 2 and 3 hr where few CVs are found (Warner 1995). Patterson et al. (2003) determined the orbital period as 140.4 minutes. QW Ser was identified as a dwarf nova by Takamizawa (1998), and $P_{\rm orb} = 107.3$ minutes was determined by Patterson et al. (2003). IY UMa is another eclipsing dwarf nova with an $P_{\rm orb} = 106.4$ minutes (Uemura et al. 2000), for an updated ephemeris see Steeghs et al. (2003). HS1340+1524 (SDSSJ1343) is a dwarf nova with infrequent short outbursts, and $P_{\rm orb} = 92.7$ minutes (Aungwerojwit et al. 2006).

Finally, there are four previously known polars among the SDSS CVs presented here. Two of them were observed in a low state: ST LMi (SDSSJ1105), one of the few polars identified in the optical (Shore et al. 1982) with $P_{\rm orb} = 113.9$ minutes (Schmidt et al. 1983; Cropper 1985); and EU UMa (SDSSJ1149), discovered with *ROSAT* (Mittaz et al. 1992) with $P_{\rm orb} = 90$ minutes (Howell et al. 1995a). The two other polars were observed by SDSS during high states, MR Ser (SDSSJ1552), identified in the PG survey (Liebert et al. 1982) with $P_{\rm orb} = 113.5$ minutes (Schwope et al. 1991), and

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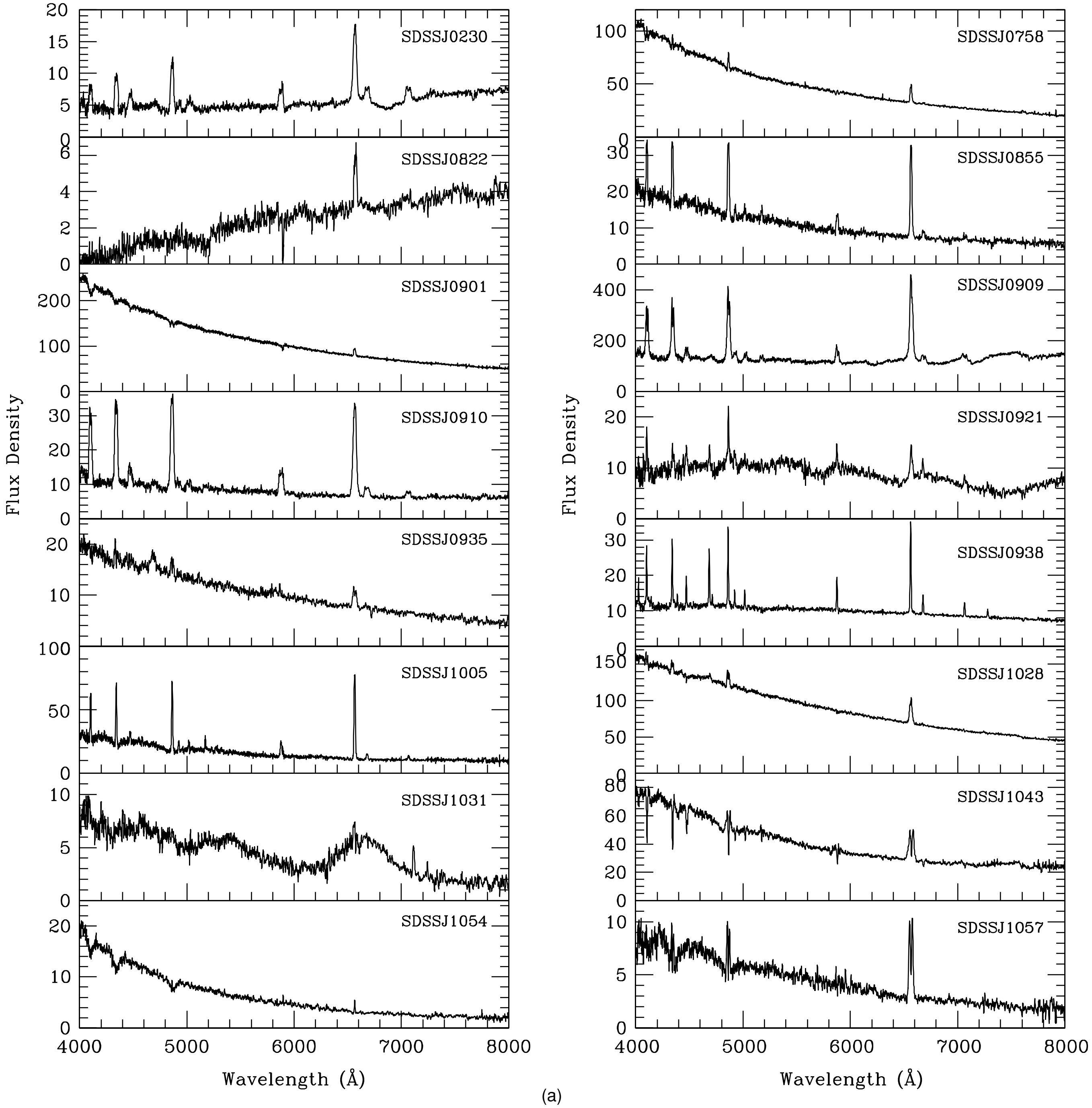
[9] IRAF (Image Reduction and Analysis Facility) is distributed by the National Optical Astronomy Observatory, which is operated by the Association of Universities for Research in Astronomy, Inc., under cooperative agreement with the National Science Foundation.



(a)

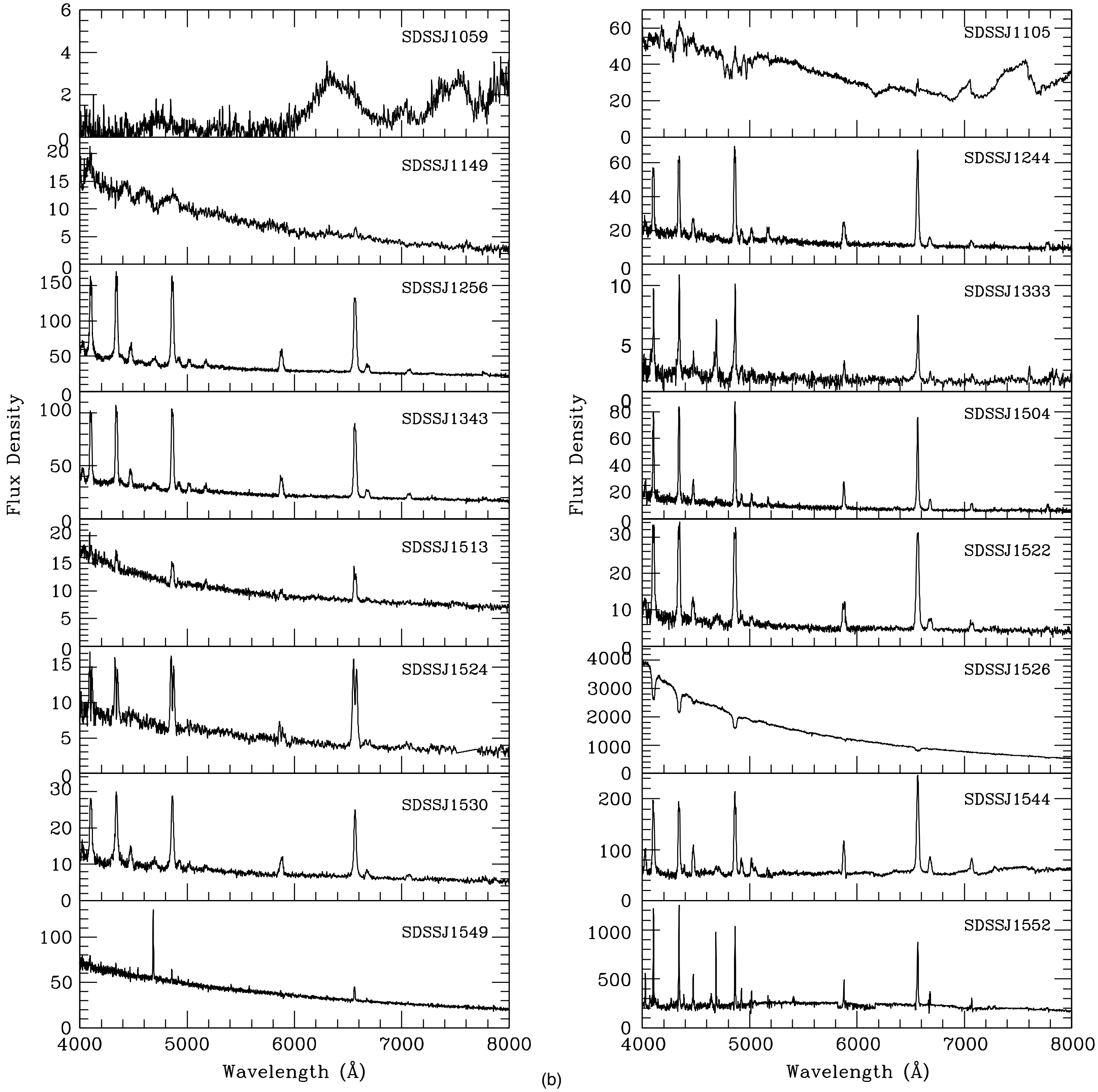
Figure 1. SDSS spectra of the 36 CVs. Vertical axis is units of flux density $F_\lambda \times 10^{-17}$ erg cm^{-2} s^{-1} Å^{-1}. The spectral resolution is about 3 Å.

RXS J161008.0+035222 (SDSSJ1610), identified as a *ROSAT* polar by Schwope et al. (2000, 2002), with recent polarimetry published by Rodrigues et al. (2006) which refined the orbital period to 109.5 minutes.

Table 1 also includes four polars that we found since Paper VI which have detailed information recently published (Schmidt et al. 2007, 2008); we include them in the table for completeness: SDSSJ0921, SDSSJ1031, SDSSJ1059, and SDSSJ1333. Of these, SDSSJ1031 and SDSSJ1059 belong to the group of extremely low mass transfer rate polars, while the rest are normal polars with high and low states of accretion. Note that the magnitudes listed for SDSSJ0921 and SDSSJ1333 in Schmidt et al. 2008 are in juxtaposed order in their table (the magnitudes are actually in the order of g, i, r, u, z instead of u, g, r, i, z as labeled.

3.2. *High Inclination Systems*

Previous work on SDSS systems has shown that those with deep central absorption in the Balmer lines typically have high inclination and show photometric eclipses. Two systems, SDSSJ1057 and SDSSJ1524 (Figure 1), show this central absorption, and are promising candidates for having deep eclipses of the white dwarf by the secondary star.



(b)

Figure 1. (Continued)

3.3. Dwarf Novae

While CVs can be generally identified by their emission line spectrum, the identification of a dwarf nova requires that an outburst is apparent. This can be apparent from a difference in the SDSS photometry versus the spectra (which are obtained at different times) or as large differences in magnitude in past USNO or DSS catalogs or in other non-SDSS observations. The known dwarf nova QW Ser (SDSSJ1526) was caught at outburst in the SDSS spectra (Figure 1) while the photometry (Table 1) is consistent with its normal quiescent magnitude near 18.

SDSSJ1005. A report of an outburst of this object by Brady & Pietz (2009) recently appeared in the vsnet,[10] thus providing a classification for this system. Subsequent searches of ASAS-3 data as reported by Kato (2009) showed previous outbursts near 12.5 mag in 2003 and 2006.

Our follow-up APO time-resolved spectra during quiescence in 2007 produced consistent results from the Hα and Hβ emission lines. The period obtained from both lines is near 113 minutes and the K amplitude is low (Figure 2 and Table 4). While further data over several nights will be needed to pin this down precisely, it is apparent that this is likely a low inclination, short period system that is near the lower edge of the period gap. The preliminary superhump period reported by Brady and Pietz is identical to our spectroscopic period within the accuracy reported.

SDSSJ1619. The SDSS photometry (Table 1) and spectrum (Figure 1) show a typical CV at quiescence, with an optical

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[10] http://vsnet.kusastro.kyoto-u.ac.jp/vsnet/

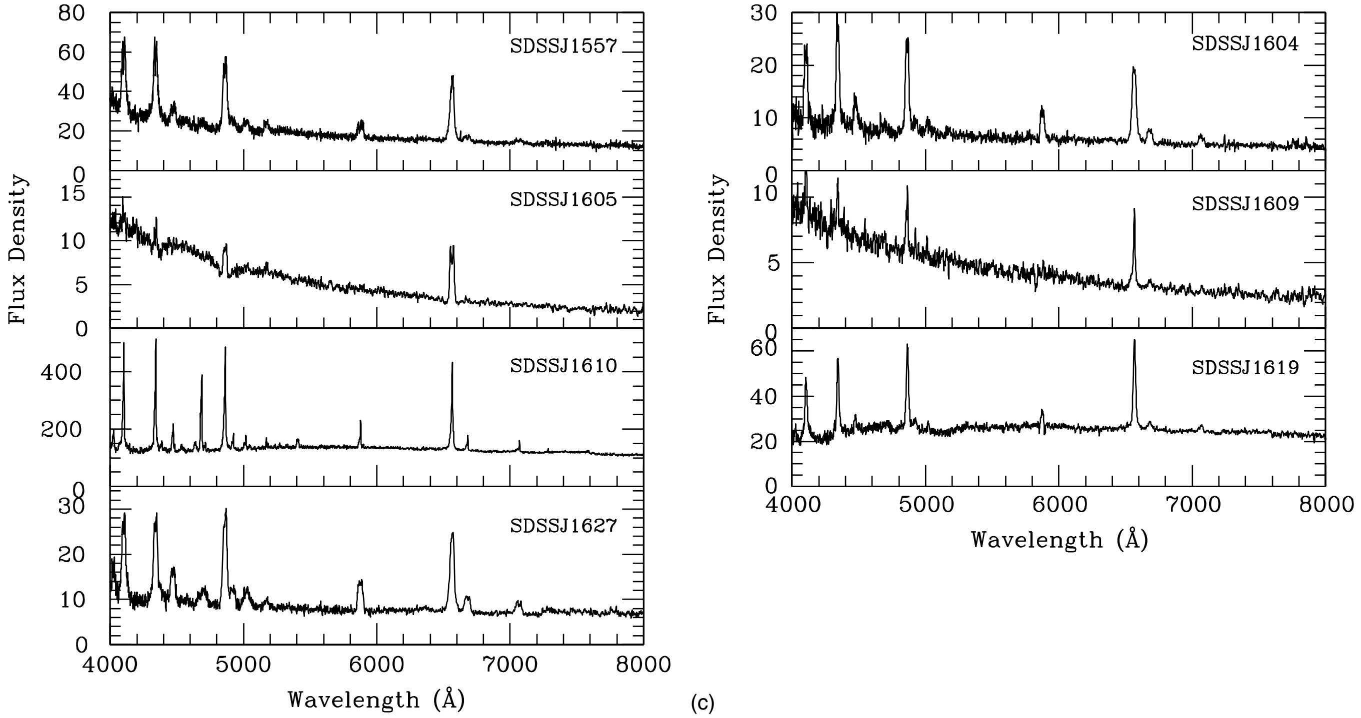

Figure 1. (Continued)

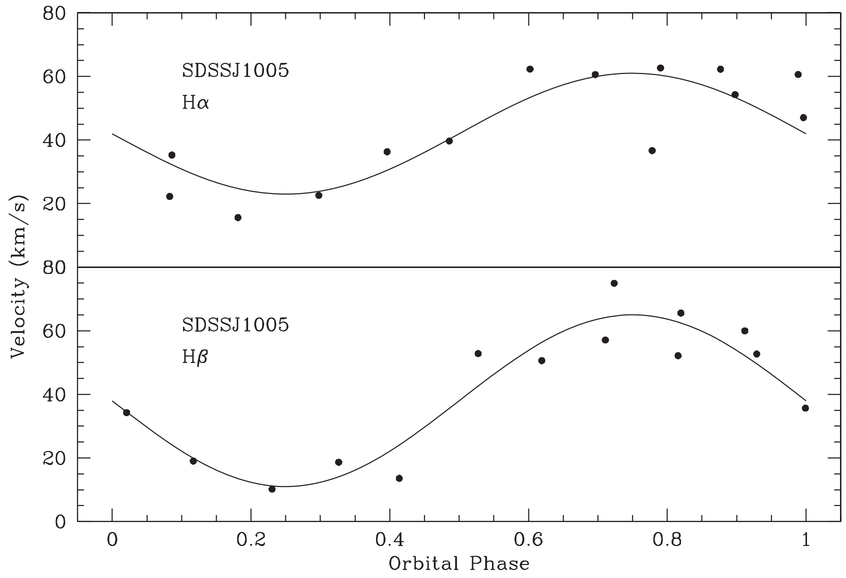

Figure 2. Hα and Hβ velocity curves of SDSSJ1005 with the best-fit sinusoids (Table 4) superposed. Sigmas of fits are listed in Table 4.

magnitude near 18.5 and Balmer emission lines with a flat decrement. However, our follow-up APO spectra (Table 2 and Figure 3) show a much brighter source (near magnitude 15.5) with strong He II 4686 emission as well as weaker Balmer emission flanked by broad absorption. The APO spectra are typical of dwarf novae at outburst, where the increased accretion at outburst results in the high excitation He line and an optically thick accretion disk which produces the broad absorption. Thus, we can narrow the classification of this object to that of dwarf nova. Our time-resolved APO data covered close to 2 hr of observation, but our measurements of the Hα, Hβ, and He II emission components did not reveal any periodic radial velocity variation outside of random variability that was less than 20 km s^{-1}. Thus, either this system has a low inclination, a long period, or the emission lines at outburst are too distorted by the underlying absorption to extract the underlying orbital motion. Further observations during quiescence are needed to determine its orbital period.

SDSSJ1627. A superoutburst has recently been detected by Shears et al. (2008), who determined a superhump period of $P_{\rm sh}$ = 156.8 minutes. Since the superhump period is usually only a few percent different from the orbital period (Warner 1995), this system appears to be one of the few in the 2–3 orbital period gap.

3.4. Novalikes with He II

The He II 4686 line is a strong indicator of a polar or of high accretion. All of the polars mentioned in Section 3.1 show this

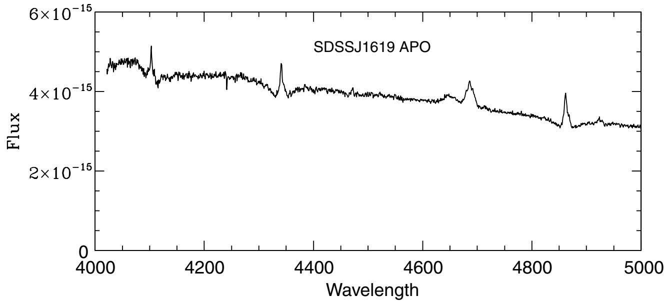

Figure 3. Combined APO spectra of SDSSJ1619 obtained on 2007 May 10 during an outburst. Note increased He II emission, Balmer absorption, and higher flux as compared to the spectrum in Figure 1. The spectral resolution is about 2 Å.

line (except for the two with extremely low accretion rates). In addition to these known polars, Figure 1 reveals three other systems with unusually strong He II4686.

SDSSJ1549. This object has a very peculiar spectrum, showing a strong continuum, weak Balmer emission but very strong He II. The SDSS spectrum is very similar to that of UMa 6 (SDSSJ0932) shown in Paper V. UMa 6 has a very long orbital period for a CV (10 hr[11]) and a deep optical eclipse (Hilton et al. 2009). Our 2.5 hr of APO time-resolved spectroscopy (Table 2) showed 40 km s^{-1} variability in both Hα and He II but no simple sinusoidal motion consistent with an orbital radial velocity. Thus, this system will require much longer monitoring to ascertain its nature.

SDSSJ0938. The spectrum of SDSSJ0938 looks typical for a polar (Figure 1) in a high state of accretion. It is virtually identical to the known polar SDSSJ1610 also in Figure 1. Spectropolarimetry will be able to provide definitive information on this issue. While our APO observations (Table 2) were not long enough to obtain an orbital period, a smooth, large amplitude (70 km s^{-1}) variation throughout the 65 minutes is consistent with a polar with a period that is below 2 hr.

SDSSJ0935. While this object has stronger He II than Hβ emission (Figure 1 and Table 3), the spectral appearance is different than for the above two objects. The continuum is very strong and the emission lines are broad and weak. This spectrum appears more like an old nova than a system containing a magnetic white dwarf (Warner 1995).

3.5. Systems Showing the Underlying Stars

The ability of SDSS to obtain spectra of CVs that are fainter than previous surveys has resulted in discovering many systems that have low accretion rates, hence accretion disks which do not overwhelm the light of the underlying stars. In these cases, the white dwarfs are revealed through their broad absorption lines flanking the Balmer emission and, if the secondary star is a late main-sequence object, it is evident by TiO features in the red. From Figure 1, it is apparent that SDSSJ1005, SDSSJ1057, and SDSSJ1605 show the white dwarf, while SDSSJ0230, SDSSJ1059, SDSSJ1105, and SDSSJ1544 show an M star (SDSSJ1105 and SDSSJ1059 are known polars with no accretion disk) and SDSSJ0805 appears to show a K star (albeit of somewhat later type than the K stars in SDSSJ0615 and SDSSJ0805 found in Paper VI).

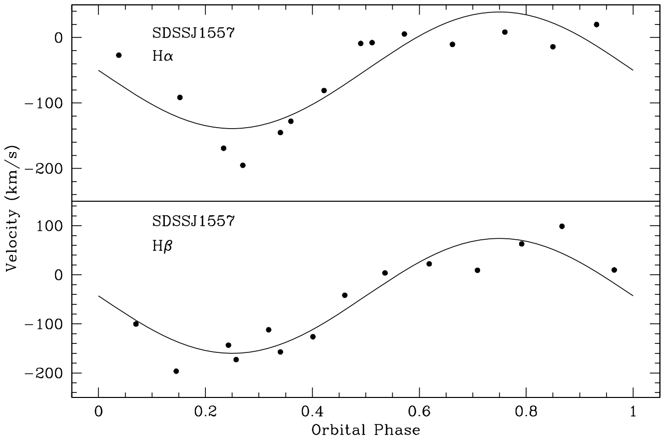

Figure 4. Hα and Hβ velocity curves of SDSSJ1557 with the best-fit sinusoids (Table 4) superposed.

3.6. Other Disk Systems

The spectra of systems with accretion disks can show a large range in variety (Warner 1995). Figure 1 shows five systems with strong, blue continua: SDSSJ0758, SDSSJ0901, SDSSJ0935 (already mentioned in Section 3.4), SDSSJ1054, and SDSSJ1513. Most of these are likely to be novalikes with large accretion rates. SDSSJ1054 may be questionable as it could be just a white dwarf and a faint active but non-interacting M star. Two spectra taken 26 days apart exist in the SDSS archive for this object and they show minor differences in the structure of the Balmer emission and absorption lines which could be due to a close binary, so we have left this in the list. Follow-up spectroscopy will determine the correct classification. The systems with weaker continua and stronger emission lines are likely candidates for short orbital period systems with lower mass transfer. For our follow-up APO spectra, we generally concentrated on these latter systems due to the way observing time is scheduled in half-nights.

SDSSJ1557. This object has strong, broad Balmer emission lines that are typical for dwarf novae systems. Our 2.5 hr of time-resolved spectra revealed a sinusoidal modulation with a period near 2 hr, which is the lower end of the period gap (Table 4 and Figure 4). The amplitude is typical for dwarf novae. The object will need to be followed photometrically to detect an outburst and confirm this as a dwarf nova.

SDSSJ0812. Follow-up 3.5 hr of time-resolved spectra of this CV that was first reported in Paper V show a high-amplitude radial velocity curve with a period near 3.7 hr, close to the length of the data set (Table 4 and Figure 5). This object thus appears to be above the period gap and has a higher accretion rate than the majority of SDSS CVs that have periods less than 2 hr.

SDSSJ1006. This system from Paper VI was targeted for follow-up spectra as it shows strong emission lines plus TiO bands from its secondary star. However, 100 minutes of spectra do not reveal a clear sinusoidal variation. There is a jump in velocities in both Hα and Hβ from red to blue (with no change in comparison lamps taken near these times) and there is a decline in flux in the spectra at this time. These properties could be an indication of an eclipse, so additional data on this object could produce interesting results.

3.7. ROSAT Correlations

Ten of the objects in Table 1 have been detected with the *ROSAT* All Sky Survey (RASS; Voges et al. 1999, 2000). The

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[11] http://cbastro.org/results/highlights/uma6

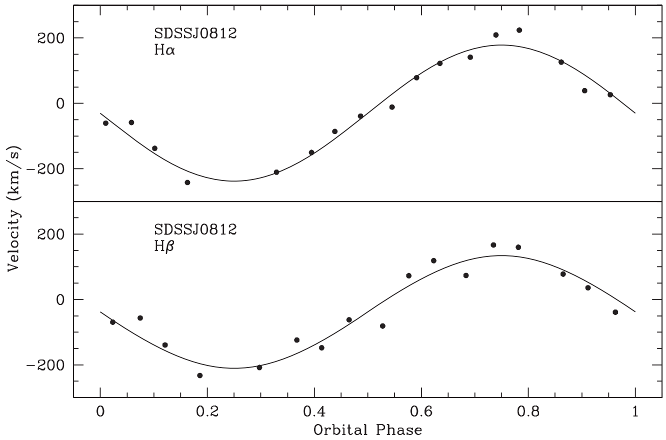

Figure 5. Hα and Hβ velocity curves of SDSSJ0812 with the best-fit sinusoids (Table 4) superposed.

Table 5
ROSAT Detections

SDSSJ	*ROSAT* (counts s^{-1})^a	Exp (s)	RXS	Type
0909	0.08 ± 0.02	364	J090950.6+184956 = GY Cnc	DN
0938	0.03 ± 0.01	409	J093838.0+534417	...
1005	0.03	414	J100511.9+191105	DN
1149	3.33 ± 0.16	127	J114955.5+284510 = EU UMa	Polar
1256	0.06 ± 0.01	476	J125637.6+263656 = GO Com	DN
1343	0.07 ± 0.02	354	J134323.1+150916	DN
1526	0.05 ± 0.02	277	J152613.9+081845 = QW Ser	DN
1552	0.04 ± 0.01	595	J155246.3+185608 = MR Ser	Polar
1557	0.014 ± 0.007	587	J155720.3+180715	...
1610	0.36 ± 0.04	494	J161008.0+035222	Polar

Note. [a]For a 2 keV bremsstrahlung spectrum, 1 counts s^{-1} corresponds to a 0.1–2.4 keV flux of about 7×10^{-12} erg cm^{-2} s^{-1}.

exposure times and count rates are listed in Table 5. Among the 10 detections are the known polars EU UMa, MR Ser, and RXJ1610+03 and the dwarf novae GY Cnc, GO Com, QW Ser, and HS1340+15. Several of the sources are only in the faint source catalog with marginal detections (no error is listed for the faint detection of SDSSJ1005). The lack of detection of the other polars such as ST LMi and the LARPS detailed in Schmidt et al. (2007, 2008) are indications of states of very low mass transfer for these systems. On the other hand, the detection of SDSSJ0938 lends further support for this object being a possible polar. As in UMa 6, the strong He II present in SDSSJ1549 is not correlated with X-ray emission.

4. CONCLUSION

The addition of these 39 objects to the previous list brings the total number of CVs in the SDSS database to 252, of which 204 are new discoveries. There are now more than 100 CVs with known or estimated orbital periods (see Gänsicke et al. 2009 for a recent summary). The distribution of periods of objects from SDSS is significantly different than previous surveys with brighter limits. The SDSS objects exist predominantly at short periods and show a period spike at 81 minutes, as predicted by binary evolution theories. Thus, this database can serve as a test bed for evolution and further period determinations will refine these numbers.

The following objects should be of high interest for future studies. Follow-up photometry, spectroscopy, and especially polarimetry of SDSJS0938 will confirm if this system contains a magnetic white dwarf. Photometry of SDSSJ1057 and SDSSJ1524 is likely to reveal eclipses which can determine inclinations and periods. SDSSJ1006 from Paper VI may also have eclipses. High time-resolution photometry of SDSSJ1005, SDSSJ1057, and SDSSJ1605 should be done to search for pulsations of the white dwarf. Long-term photometry of SDSSJ1549 is needed to determine if the large differences in magnitude that are apparent are due to a long orbital period with eclipses (like UMa 6) or different states of low and high accretion. Spectroscopy (especially in the IR) for the two systems showing indications of the secondary star (SDSSJ0230 and SDSSJ1544) can produce better information on the secondary and the likely longer orbital periods in these two systems.

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