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Cataclysmic Variables in the First Year of the Zwicky Transient Facility

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ABSTRACT

We have used the GROWTH Marshal to identify cataclysmic variables (CVs) during the first year of operation of the Zwicky Transient Facility (ZTF). Filtering on amplitude, time, and color produced 335 objects during the first year of testing and operation, with 90 being previously confirmed CVs, 215 being good candidates based on the shape and color of their light curves obtained during 30-400 days of observations, and the remaining 30 being possible CVs but with too few data points to be listed as good candidates. Almost half the good candidates are within 10 deg of the galactic plane, in contrast to other large surveys which have avoided crowded fields. The available Gaia parallaxes are consistent with sampling the low mass transfer CVs, as predicted by population models. Followup spectra have confirmed Balmer emission lines in 23 objects, with a few showing high excitation HeII emission. Our results demonstrate that many surveys are required to capture all the CVs in the galaxy, especially those that target the galactic plane.

Keywords: editorials, notices — miscellaneous — catalogs — surveys

1. INTRODUCTION

The Zwicky Transient Facility (ZTF) is a northern all-sky survey that uses the Palomar 48 inch telescope equipped with an improved camera with a 47 deg field of view (Bellm et al. 2019a,b; Graham et al. 2019). The project uses 40% of the time for the public, 40% for partnerships, and 20% for Caltech. As part of the public portion, the available sky is sampled in Sloan g or r filters every 3 nights and the available galactic plane every night in both g and r. Alerts on all variable objects are

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available every night. Commissioning took place in the latter part of 2017 with the official start of the 3 year survey on March 18, 2018 and the first public data release occurred on May 8, 2019.

The alerts are fashioned from difference images between a reference field (consisting of a minimum of 12 images) and the new field. These alerts pass through the GROWTH Marshal (Kasliwal et al. 2019) which uses various filters constructed by participants to select specific types of variables and transients. One such filter was created to cull out cataclysmic variables (CVs), which consist of close binaries with mass transfer from a late main-sequence secondary to a white dwarf (Warner (1995) reviews all types of CVs). In the CVs with a non-magnetic white dwarf (B<1 MG), the mass transfer accumulates in a disk before accreting onto the white dwarf. The amount of mass transfer and accretion determines what the light curve of a specific CV will look like. Those with relatively low values of transfer will undergo a disk instability that results in a dwarf nova outburst (a rise in brightness of 2-9 mag within 1-3 days. the high brightness lasting for 1-15 days, and a subsequent return to quiescence), with a repetition timescale of weeks to months. The lowest mass transfer systems are those with the largest amplitudes, the longest times at outburst and the longest recurrence time between outbursts (years). The highest rates of mass transfer result in novalike (NL) systems, which have no outbursts but sometimes undergo several magnitude transitions between low and high accretion states that can last for weeks at a time. In systems with a magnetic white dwarf, the inner disk region can be channelled to the magnetic poles via accretion curtains (called intermediate polars, IPs) or no disk exists as the mass transfer goes directly to the white dwarf magnetic poles in the highest field cases (polars), and also in a few IPs. With no disk, there are no outbursts but high and low states of accretion exist, resulting in several magnitude changes in their light curves on timescales of weeks. The colors of CVs are generally blue ($g - r$ close to 0 amd even bluer during an outburst) due to the contributions of the white dwarf and the accretion disk. However, long period systems with K type secondaries or those with magnetic white dwarfs and resulting cyclotron emission from the accretion pole can be redder in color.

To find CVs, the Growth filter used an amplitude detection of 2 mags within a timespan of 3 days and a color selection of $g - r < 0.6$. The filter began its full operation on June 5, 2018. With this filter, it was common to find 25-50 candidates per month when the weather allowed normal observations. This paper presents the resulting previously confirmed CVs and CV candidates found using the GROWTH Marshal up to the time of the first public data release.

2. IDENTIFYING CVS

Each night, the light curves of the filtered objects provided by the Marshal were scanned by eye to determine a possible dwarf nova outburst or a change in state of a novalike system within the 30 day interval depicted by the Marshal. Likely candidates were saved and checked against known sources via SIMBAD, the Sloan Digital Sky Survey (York et al. 2000), the Catalina Real-time Transient Survey (Drake et al. 2009, 2014), MASTER (Lipunov et al. 2010) and ASAS-SN (Shappee et al. 2014). The saved sources continued to be monitored to help determine the correct classification. Other ZTF groups also transferred objects that passed their different filters (e.g. nuclear transients, SN, etc) if they thought they might be CVs. Followup spectra were obtained using several telescopes, sometimes with multiple spectra on the same object (27 systems with the Palomar 60in, 5 with the 200 in, 10 with the Keck 10m, 14 with the Apache Point Observatory (APO) 3.5m, and 2 with the Liverpool 2m telescope) to confirm candidates. The presence of Balmer absorption lines (from the accretion disk if obtained at outburst) or Balmer emission (from the decline or quiescent state) or the presence of HeII emission (indicative of a magnetic white dwarf or a very high mass transfer system) were used as confirmation criteria.

The Palomar spectra were obtained using the SED Machine (Blagoradnova et al. 2018; Rigault et al. 2019), which is a low resolution (50Å) integral field spectrograph operating from 3650-10,000Å. An automatic pipeline reduces the data and uploads it to the Marshal. The Double Beam Spectrograph was used on the 200 in, the Low Resolution Imaging Spectrometer (LRIS) on Keck and the Spectrograph for the Rapid Acquisition of Transients (SPRAT) on the Liverpool telescope, and uploaded after reduction pipelines. The APO data were obtained with the Double Imaging Spectrograph using either low resolution (2Å) or high resolution (0.6Å) gratings to cover the Balmer lines and the data reduced using *IRAF* routines to calibrate the data via He, Ne, Ar lamps and flux standards obtained during each night. The APO blue CCD suffered contamination problems throughout the year, so most of the data collected were from the red side of the dichroic (5500-9000Å).

3. RESULTS

The yearlong scans of the CV Marshal yielded 90 previously confirmed (from spectra or from the presence of a superhump outburst feature (Warner 1995)) CVs, 215 good candidates based on their light curves and 30 objects which might be CVs but the data are too limited to tell for sure. Table 1 lists the previously confirmed objects, Table 2 the good candidates and Table 3 the remaining possibilities. Some sources were listed as candidates in CRTS or MASTER, but if they have not been confirmed, we placed them in Table 2. In the rest of this paper, we will refer to objects by their abbreviated RA(HHMM) and Dec(Deg) i.e. ZTF0014+59. The tables also provide the galactic latitude, the range in magnitude observed by ZTF, the Gaia parallax and errors in mas (for those objects with a measurement that was more than 3 times the error), the number of outbursts observed in the Marshal light curves, the interval of coverage by ZTF in days for those outbursts, if the source is in the Sloan Digital Sky Survey (SDSS) footprint, the number of outbursts visible in CRTS if covered by that survey, any spectra obtained with the ZTF instruments or available from the SDSS or the literature, and any other relevant information.

4. DISCUSSION

The easiest systems to classify as CVs are those that show a long string of observations at quiescence along with one superoutburst (SOB) that has a large amplitude (typically 5-9 magnitudes) and a long duration (typically 3 weeks). A typical example (ZTF1727+23) is shown in Figure 1. The SOB often has a distinct shape, with a linear slowly declining plateau following the peak magnitude that lasts for 1-2 weeks, then a steep decrease toward the quiescent magnitude. In a few cases, there are one or more rebrightening episodes during the decline (examples ZTF2231+33 and ZTF1841+37 in Figure 1). These systems are known as WZ Sge stars (Warner 1995) or Tremendous Outburst Amplitude Dwarf novae (TOADS) (Howell et al. 1995). Modeling of TOADS has shown that they are the systems with the lowest accretion rates among dwarf novae (Howell et al. 1995) and the ones that population synthesis models (Howell et al. 2001) predict should dominate CVs. They should have evolved to the shortest orbital periods in their evolution during the lifetime of the galaxy. Most dwarf novae that have orbital periods less than 2 hrs show both SOBs and normal oubursts. The systems with larger accretion rates are generally those with longer orbital periods and with short recurrence times for outbursts, so they are readily found in sky surveys with coverage of weeks to months. An example of this kind of system is ZTF0613+06 in Figure 1. All objects in Table 2 show outbursts with one of the types described above. There also exist novalike systems which do not show outbursts but do exhibit high and low states of accretion that last for many days. Two of these previously known systems, ZTF0854+39 (FR Lyn), and ZTF1631+69 (shown in Figure 2) were found in the Marshal, but none of the candidates in Tables 2 or 3 showed this behavior. The filter works best to detect outburst behavior and will need to be modified to pick up the generally slower transitions between high and low states.

For the most part, the objects in Table 3 did not have enough data to unambiguously determine if their variability is due to a dwarf nova outburst or to some type of pulsational instability. As the survey proceeds, more observations may provide a correct classification.

4.1. *The galactic plane*

One of the unique features of ZTF is its frequent observation of the galactic plane. Previous surveys such as CRTS (Drake et al. 2014) generally avoided latitudes within 10° of the galactic plane due to crowding and large pixel sizes. The 1 arcsec pixels of ZTF allow the nightly plane observations to provide variable sources that can be identified in the Marshal. Figure 3 shows the distribution of galactic latitudes for the objects in Tables 1 and 2. The number of objects lying within 10° of the galactic plane confirm the higher densities expected there. Of the previously identified CVs (Table 1), only 23 (26%) are within 10°, while among the good candidates, the number is 100 (47%) for Table 2 and similar for the possible candidates (Table 3) with 12 (40%).

4.2. *Absolute Magnitudes*

The available Gaia parallaxes provide distances that enable good absolute magnitudes and heights above the plane without relying on average absolute magnitudes at quiescence or outburst. However, the sample is small due to the current limits on the Gaia parallaxes. Table 1 (confirmed CVs) has 56 (62%) with good parallax measurements but Table 2 has only 52 (24%) and Table 3 has 12 (40%). These numbers are consistent with the closest systems being found in previous discoveries and the new candidates having large distances and/or fainter brightness due to low mass transfer. Figure 4 plots the absolute magnitude of the objects from Tables 1 and 2. In the cases where ZTF did not get a detection for the quiescent magnitude, the upper limits mean that the absolute magnitudes will be even fainter than shown. Past results on absolute magnitudes of dwarf novae at quiescence (Warner 1995) have shown a range from 7.5-11, depending on the orbital period. Figure 4 shows that the majority of the ZTF sources are between 10-12.

4.3. *Spectroscopic Confirmations*

Many of the SEDM spectra were obtained near outburst, when the accretion disk is dominant and producing a blue continuum or weak absorption lines. Thus, the low resolution usually only showed the continuum. The higher resolution and larger telescopes of the 200 in, Keck and APO enabled better determination of Balmer and Helium emission lines as the systems evolved to quiescence. In addition, a few candidates were found to have spectra available from SDSS. In total, 27 of the systems in Table 2 were able to be positively confirmed as CVs with noticeable Balmer or Helium emission lines (those designated with a small letter e in the Spec column of Table 2). Figure 5 shows the emission line spectra from the ZTF Marshal followup obtained with Caltech facilities (coverage from 4000-9000Å) while Figure 6 shows the red region from 5500-9000Å) available from APO data.

4.4. *Notes on Individual Systems*

Brief descriptions of the systems with interesting features in their spectra or lightcurves are provided below.

4.4.1. *He II objects*

Figure 5 shows that ZTF2123+15 has He II stronger than Hβ. Thus, this is a strong candidate for either an IP or a member of the class of high mass transfer rate novalikes called SW Sex stars (Thorstensen et al. 1991; Hoard et al. 1998) that have orbital periods between 3-4 hrs and strong He II.

ZTF0451+16 (Figure 5) shows strong Balmer and He I lines as well as relatively strong He II. It does not show the strong blue continuum that is characteristic of a high mass accretion rate system.

ZTF1631+69 (Table 1) has been identified as a CV (Appenzeller et al. 1998), and is reported in the ROSAT and XMM catalogs, but there is no detailed study of this system available in the literature. The ZTF light curve shows the existence of high and low states, a common feature of high accretion rate SW Sex systems as well as those containing highly magnetic white dwarfs (polars and IPs). A series of 5 sequential spectra obtained over the span of an hour at APO on May 24, 2019 shows strongly doubled Balmer lines along with He II, as well as large changes from one spectrum to the next (Figure 7). The velocities of the Hα and Hβ lines show a portion of a sinusoidal variation over 200 km s^{-1} during the hour but the timespan is too short to determine an orbital period. The doubled lines are a signature of an accretion disk while the high excitation could indicate a magnetic white dwarf. Further data are needed to ascertain if this is an IP system.

4.4.2. *Strong Balmer lines*

Figures 5 and 6 show that ZTF0422+29, ZTF0429+18, ZTF0914+67, ZTF1315+42, ZTF1800+15, ZTF1704+26, ZTF1857+32, ZTF1900+30, and ZTF2248+38 all have the prominent Balmer emission lines typical of quiescent dwarf novae. ZTF0819+21, ZTF1716+29, ZTF1810+32, ZTF1834+54, ZTF1841+37 show weak Hα in emission while the bluer Balmer lines are in absorption. The spectra of these systems were obtained close to their outburst brightness and reflect the prominence of the thick accretion disk at those times.

4.4.3. *Peculiar Lightcurves*

ZTF1841+37 (Figure 1) shows a SOB followed by 6 normal outbursts or rebrightenings within 60 days. If this sequence repeats in future data, this could be a new ER UMa system. The cyclic behavior of SOBs interspersed with normal outbursts in this small group of CVs is thought to be a combination of high mass transfer rate combined with a tidal instability present in short period systems (Osaki 1996).

There are 4 systems whose shape and length of outburst, as well as only upper limits at quiescence, make them possible candidates for novae. Figure 8 shows their light curves. ZTF0456+50 and ZTF1749+19 have redder colors than a typical dwarf nova at outburst, which could be attributed to reddening in ZTF0456+50, as its galactic latitude is only 5 deg above the plane. All 4 show a peculiar hump in their light curves during the decline from outburst. The hump could be due to a rebrightening event as sometimes seen after a SOB (see ZTF2231+33 shown in Figure 1), but the hump color seems to be redder than the rest of the lightcurve in ZTF0456+50 and ZTF0204+57, and blue in ZTF2359+56 and ZTF1749+19. Thus, if they are all the same type of system, it is difficult to explain all the colors with a disk rebrightening. Without spectra, it is not possible to determine if these objects are very low mass transfer nearby systems with SOBs or more distant novae. Once the Gaia determinations of the distances and absolute magnitudes are available, correct classifications can be made.

SIMBAD identifies ZTF1752+07 with V982 Oph and classifies it as a Long Period Variable Candidate, but the ZTF lightcurve (Figure 8) and the blue colors at bright states are more consistent with a dwarf nova classification.

5. CONCLUSIONS

Using the GROWTH Marshal to filter nightly alerts from ZTF g and r light curves throughout the first year of operation resulted in the identification of 100 known CVs, 207 good candidates based on the shape, amplitude and colors of the light curves, and an additional 30 potential candidates which require further data. Followup spectra obtained on a variety of 1.5-10 meter telescopes allowed spectroscopic confirmation of 21 of the 207 good candidates from Balmer emission lines, with an additional two with SDSS spectra. Unlike previous surveys, almost half of the new ZTF candidates are located within 10 degrees of the galactic plane, demonstrating the capability of the ZTF camera and software to discover objects in crowded fields. While only a quarter of the good candidates have available and significant Gaia parallaxes, their absolute magnitudes are consistent with the faint end of the CV distribution (10-12), implying low mass transfer rates for the survey population, similar to CRTS. A few objects with spectra show high excitation He II lines and deserve further time-resolved spectra to determine their correct classification as either a system containing a magnetic white dwarf or an SW Sex system. Hour long time-resolved spectra of the known CV ZTF1631+69 shows strong He II along with doubled Balmer emission lines, implying an IP origin. A previously identified long period variable (V982 Oph) appears to be more consistent with a dwarf nova classification.

While the available filter is not complete in finding all the CVs, it does demonstrate that even with several ongoing surveys i.e. CRTS, ASASSN, MASTER, there are some systems being missed, especially those in the galactic plane. Completeness in any ground survey is difficult to obtain due to weather and software ability in crowded fields. Additionally, followup spectra of all the candidates is a time-consuming venture and will require increasingly large telescopes to obtain spectra at quiescent magnitudes. Unfortunately, classification is best near quiescence when the emission lines produce the most information from the intensity and shape as to the correct type of CV. Some compromise can be reached by obtaining observations midway from outburst to decline.

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Facilities: APO:3.5m

REFERENCES

Appenzeller, I., Thiering, I., Zickgraf, F. J. et al. 1998, ApJS, 117, 319

Bellm,E. C., Kulkarni, S. R., Graham, M. J. et al. 2019, PASP, 131, 018002

Bellm, E. C., Kulkarni, S. R., Barlow, T. et al. 2019, PASP, 131, 068003

Blagoradnova, N., Walters, et al. 2018, PASP, 130, 035003

Breedt, E., Gänsicke, B. T., Drake, A. J. et al. 2014, MNRAS, 443, 3174

Drake, A. J., Djorgovski, S. G., Mahabel, A. et al. 2009, ApJ, 696, 870

Drake, A. J., Gänsicke, B. T., Djorgovski, S. G. et al. 2014, MNRAS, 441, 1186

Graham, M. J., Kulkarni, S. R., Bellm, E. C. et al. 2019, PASP, 078001

Hoard, D. W., Szkody, P., Still, M. D., Smith, R. C., Buckley, D. A. H. 1998, MNRAS, 294, 689

Howell, S. B., Nelson, L. A. & Rappaport, S. 2001, ApJ, 550, 897

Howell, S. B., Szkody, P., & Cannizzo, J. K. 1995, ApJ, 439, 337

Kasliwal, M. M., Cannella, C., Bagdasaryan, A. et al. 2019, PASP, 131, 038003

Lipunov, V., Kornilov, V., Gorbovskoy, E. et al. 2010, AdAst, 349171

Osaki, Y., 1996, PASP, 108, 39

Rigault, M., Neill, J. D., Blagoradnova, N. et al. 2019, A&A, 627, 115

Shappee, B. J., Prieto, J. L., Grupe, D. et al. 2014, ApJ, 788, 48

Thorsensen, J. R., Ringwalkd, F. A., Wade, R. A., Schmidt, G. D., Norsworthy, J. E. 1991, AJ, 102, 272

Warner, B. 1995, Cataclysmic Variable Stars (New York: Cambridge Univ. Press)

York, D.G., Adelman, J., Anderson, J. E. et al. 2000, AJ, 120, 1579

Table 1. Known Confirmed CVs

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	ID & Other Surveys[b]
17aaaemzh	00 15 38.27	+26 36 56.5	-35.6	13.8-21.7	1.64 ± 0.19	1	125	Y	Y3	SD	AT2016eav,G
18abdlywu	00 38 54.83	+61 13 00.2	-1.6	14.3-20.5	1.79 ± 0.26	2	224	—	—	—	KP Cas
18abgopgb	01 07 03.88	+42 43 12.0	-20.1	15.5-20.0	1.06 ± 0.25	SOB	315	Y	Y3	AP	IZ And,AT2018akr
17aaawpsz	02 13 15.49	+53 38 22.8	-7.3	16.8-20.0	—	2	137	—	—	—	MOT,Gx,Atel5536,K
18acgplgw	02 50 00.20	+37 39 22.1	-19.5	14.3-20.6	1.99 ± 0.11	4	153	—	Y3	—	PY Per
18aabeymw	03 20 15.29	+44 10 59.1	-11.0	15.3-20.9	2.11 ± 0.24	SOB	143	Y	—	—	USNO,K
18abtmzoi	04 06 59.82	+00 52 43.7	-35.3	15.4-20.8	1.78 ± 0.20	1	179	Y	Y3	—	CBET1463
17aaaslud	04 08 34.99	+51 14 48.1	-0.4	13.7-21.0	1.71 ± 0.05	6	250	Y	—	—	FO Per
17aaarlrs	04 09 12.17	+48 22 06.2	-2.5	16.2-20.3	1.11 ± 0.11	11	230	—	—	—	MY Per
18abscxct	04 23 32.91	+74 52 50.2	17.5	13.3-19.4	3.52 ± 0.11	SOB	223	—	—	—	HamburgSurvey
17aaacdos	04 53 16.88	+38 16 28.4	-3.6	15.0-19.0	1.69 ± 0.34	7	233	—	—	—	HV Aur
17aacucfy	05 01 24.15	+20 38 17.7	-12.9	15.8-20.2	1.84 ± 0.21	5	163	—	Y3	AP	ATel2266
17aaavfwx	05 06 13.12	-04 08 07.7	-25.2	13.3-20.1	2.66 ± 0.12	2	124	Y	Y3	—	AQ Eri
17aadaxwu	05 47 48.38	+28 35 10.9	0.2	14.1-16.5	1.83 ± 0.07	1	3	—	—	—	FS Aur
18abwsres	05 58 45.48	+39 15 33.0	7.6	14.2-19.0	1.81 ± 0.25	SOB,1	237	—	—	—	USNO,AT2016ggz,K
17aacpcfv	06 12 04.47	+25 28 32.6	3.4	17.2-20.0	—	2	327	Y	—	—	HQ Gem,AT2017gbf
17aadnmap	06 15 43.92	+28 35 08.4	5.6	16.6-20.0	2.29 ± 0.39	HL	68	—	—	—	KR Aur
17aacklbl	06 16 43.23	+15 24 11.2	-0.5	13.2-20.0	2.02 ± 0.11	8	541	—	—	—	CZ Ori
18aaahnyx	07 18 03.74	+64 47 44.82	27.2	15.3-18.2	1.57 ± 0.16	1	217	Y	Y2	AP	MOT,AT2018hzr,PTF
18aagqdbp	07 44 19.75	+32 54 48.2	24.8	17.8-20.3	—	2	480	Y	Y4	—	AM CVn type
18aaicnwh	07 50 59.97	+14 11 50.2	19.5	15.9-20.3	1.32 ± 0.28	2	411	Y	Y3	SD	MOT
17aacbiid	07 51 07.52	+30 06 28.2	25.3	15.1-20.6	—	2	300	Y	Y2	—	K
17aacplzj	07 56 48.05	+30 58 05.0	26.7	16.8-20.4	—	SOB	87	Y	Y3	SD	—
17aabyrpg	08 08 46.20	+31 31 05.9	29.3	14.2-20.8	—	2	556	Y	Y7	SD	PTF,G
18aacluoi	08 16 10.82	+45 30 10.1	33.4	15.9-20.3	—	2	470	Y	Y3	SD	—
18aaadlpa	08 54 14.01	+39 05 36.7	39.8	16.2-19.3	1.82 ± 0.38	HL	472	Y	HL	SD	FR Lyn

Table 1 continued on next page

Table 1 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	ID & Other Surveys[b]
18aaacmsd	09 43 25.89	+52 01 28.8	47.1	15.2-20.6	—	5	346	Y	Y2	SD	—
17aaapome	10 05 15.37	+19 11 07.9	51.2	13.0-19.7	2.57 ± 0.24	3	411	Y	Y2	SD	—
18abcsatf	10 18 12.99	+71 55 42.9	40.6	14.4-20.5	—	3	326	—	—	—	CI UMa
17aacldol	10 19 47.24	+33 57 53.3	56.8	14.9-20.4	1.37 ± 0.25	2	562	Y	Y3	SD	AC LMi
18aaadhmx	10 43 56.60	+58 07 31.4	51.8	15.8-20.8	—	2	384	Y	—	SD	IY UMa
17aaajlbs	10 54 30.51	+30 06 09.1	64.2	14.3-18.7	3.08 ± 0.12	4	562	Y	Y2	SD	SX LMI
17aaajlfw	11 05 39.78	+25 06 28.0	66.2	14.0-19.5	8.83 ± 0.08	HL	532	Y	HL	SD	ST LMi
18aaadcme	11 35 51.70	+53 22 46.2	60.3	15.1-20.6	—	4	416	Y	—	SD	—
18aaadclg	11 57 44.85	+48 56 17.9	65.8	15.2-20.7	0.60 ± 0.03	5?	480	Y	Y	SD	BE UMa
18aajoejk	12 27 40.85	+51 39 24.7	65.1	15.06-20.78	2.75 ± 0.20	2	397	Y	Y4	SD	—
19aaqhcmn	12 32 25.77	+14 20 41.7	76.5	13.4-20.6	—	SOB	103	Y	—	—	AL Com,G
18aambkqd	13 05 14.74	+58 28 56.2	58.6	16.9-20.9	—	5	410	Y	Y3	SD	—
18aalrikz	13 07 53.84	+53 51 30.3	63.1	15.8-20.9	1.51 ± 0.12	HL	408	Y	Y4	SD	EV UMa
18aautxxk	14 11 18.31	+48 12 57.6	63.8	13.0-19.5	2.36 ± 0.30	SOB	410	Y	Y3	K,AP	AM CVn type
18abfyzmf	14 25 48.07	+15 15 01.2	65.1	17.1-20.8	—	2	324	Y	Y2	—	K
18aagsgqc	14 57 44.75	+40 43 40.5	60.7	12.8-21.0	—	2	312	—	Y2	—	TT Boo
18abaulyr	15 34 12.18	+59 48 31.82	47.2	14.8-20.0	1.74 ± 0.43	1	31	Y	Y1	—	DM Dra
18aaisedb	15 51 22.39	+71 45 11.6	39.1	15.0-19.8	1.89 ± 0.05	18	409	—	—	—	SS UMi
18adbahiw	15 56 44.23	-00 09 50.4	37.8	14.5-19.3	3.24 ± 0.21	1	125	Y	Y3	SD	V493 Ser,AT2018hbm
18aaomiig	16 00 03.71	+33 11 13.7	49.1	14.1-20.0	—	SOB,1	389	Y	Y12	—	VW CrB
18abjzbhm	16 04 19.02	+16 15 48.3	44.2	17.5-20.0	1.10 ± 0.27	1	308	Y	Y5	SD	MNRAS
18aauxwft	16 19 35.80	+52 46 31.6	44.0	16.3-21.0	2.28 ± 0.23	HL	383	Y	Y2	SD	—
18aabpwzq	16 22 07.60	+19 22 36.5	41.3	15.6-19.7	1.01 ± 0.17	3	317	Y	—	SD	V589 Her
18abaaewz	16 31 00.23	+69 50 01.2	37.2	17.2-21.0	—	HL	379	—	Y2	AP	AT2018fmi,ROSAT,XMM
18aaovjvr	16 52 44.83	+33 39 25.5	38.3	18.1-20.1	—	8	411	Y	Y1	SD	G
18aaiytds	17 27 58.13	+38 00 22.5	32.0	14.6-20.9	—	4	27	Y	—	MDM	MOT
18aajtkma	17 30 08.36	+62 47 54.3	33.2	15.6-20.0	—	3	236	Y	—	SD	—
18aalafea	17 31 02.22	+34 26 33.1	30.7	16.3-20.7	—	SOB	408	Y	Y1	AP	ASASSN-15cm
18aakzxki	17 42 09.17	+23 48 29.4	25.2	14.2-20.0	1.26 ± 0.16	5	380	Y	Y3	—	V660 Her,AT2018cyb

Table 1 continued on next page

Table 1 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	ID & Other Surveys[b]
18abetddh	17 47 14.33	+15 00 47.5	20.8	17.1-20.0	—	8	354	Y	Y2	—	CRTS
18aajrvst	17 48 16.33	+50 17 22.9	30.4	16.4-20.6	1.35 ± 0.25	11	386	Y	Y3	—	AT2016bnf,MOT
18aaslagi	18 05 46.35	+31 40 17.7	22.9	18.6-19.0	1.83 ± 0.18	2	365	—	Y4	—	V1008 Her
18abbprmq	18 08 44.69	+34 27 23.9	23.2	17.8-20.0	—	SOB,1	101	—	—	—	V631 Her
18aamigoo	18 16 13.17	+49 52 05.1	25.9	12.3-20.0	11.40 ± 0.02	2SOB	379	—	Y2	—	AM Her
18abdhozj	18 32 11.38	+61 55 06.0	25.9	15.8-19.0	—	2	339	—	—	AP	ASASSN-13ah,ATel5052
18aakzfjo	18 44 26.67	+37 59 51.9	17.6	13.5-19.0	2.22 ± 0.13	12	382	—	—	—	AY Lyr
18aakzafr	18 44 39.18	+43 22 28.0	19.4	15.5-20.0	0.94 ± 0.08	5	379	—	Y2	—	V344 Lyr
18aapgtye	18 53 00.76	+45 27 08.2	18.7	16.0-20.0	0.86 ± 0.19	5	376	—	Y2	—	KIC,G
8abdkpgs	19 14 43.53	+60 52 13.8	20.8	15.3-19.9	—	1	336	—	—	—	CBET1535,AT2017eqn,K
18aavetqn	19 18 42.00	+44 49 12.4	14.3	15.5-21.0	1.22 ± 0.31	2	228	—	—	—	KIC,Gx,ATel6187,AT2018fao
18aaptcay	19 19 05.19	+48 15 06.1	15.6	18.5-22.7	—	9	378	—	—	—	AM CVn type,PTF1
18abcccnr	19 22 41.96	+52 43 59.0	16.8	14.0-21.0	—	4	327	—	—	—	V1113 Cyg
18aauefbw	19 27 48.53	+44 47 24.6	12.8	16.8-20.0	1.16 ± 0.17	2	371	—	—	—	KIC,G
18aaptcqq	19 44 19.29	+49 12 57.3	12.3	18.2-20	—	13	366	—	—	—	KIC, Gx
18abmszln	19 48 14.46	+34 52 01.1	4.7	16.4-20.8	—	2	277	—	—	—	V1153 Cyg
18aasncio	19 48 23.31	+36 26 23.0	5.4	14.0-20.0	1.95 ± 0.05	9	361	—	—	—	V811 Cyg
18aawbluo	19 53 04.93	+21 14 48.8	-3.2	15.5-18.3	0.62 ± 0.05	4	349	—	—	—	V405 Vul
18abobptn	19 57 18.83	-09 19 21.5	-18.8	12.6-18.6	3.19 ± 0.06	4	300	Y	Y2	—	UU Aql
18abjhdua	19 58 37.08	+16 41 28.4	-6.6	14.9-20.6	1.50 ± 0.34	1	76	—	—	—	AW Sge
18aawvwks	19 59 52.40	+39 13 59.8	4.9	15.3-20.7	—	2	347	—	—	—	V337 Cyg
18aavzjuw	20 00 05.22	+22 56 06.0	-3.7	17.0-20.0	0.76 ± 0.11	5	350	—	—	—	SW Vul
17aabopqx	20 12 13.66	+42 45 50.9	4.8	16.3-19.7	1.51 ± 0.14	4	342	—	—	—	V1316 Cyg
18aaypnnd	21 08 33.97	+39 05 35.3	-5.8	15.7-18.4	1.73 ± 0.07	6	332	—	—	—	Lanning386
18aazsdnv	21 26 24.12	+25 38 26.7	-17.7	14.3-20.8	1.88 ± 0.33	5	327	Y	—	—	MOT,AT2016gwu,ATel5111,K
17aaaqgbm	21 34 15.86	+49 11 26.3	-2.0	15.3-19.0	1.83 ± 0.12	1	331	—	—	—	V1081 Cyg
17aaawglf	21 44 03.78	+44 39 02.04	-6.5	16.0-20.0	0.99 ± 0.29	10	328	—	—	—	V2209 Cyg
18abcsuit	21 47 38.40	+24 45 54.0	-21.8	13.8-21.0	2.01 ± 0.22	3	208	Y	Y3	—	K
18abqdtes	21 54 33.97	+23 54 00.1	-23.5	16.2-21.0	—	2	106	—	—	SM	MOT

Table 1 continued on next page

Table 1 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	ID & Other Surveys[b]
17aaaedpn	21 57 16.44	+52 12 00.8	-2.0	16.4-21.0	—	7	333	—	—	—	V1404 Cyg
18abcqadc	22 19 10.14	+31 35 22.8	-21.0	17.2-20.4	—	4	136	Y	Y2	—	PTF1
18abigrzf	22 21 44.77	+18 40 07.9	-31.6	13.3-19.0	5.23 ± 0.09	3	317	Y	Y1	SD	V521 Peg
18aaznfkp	22 23 04.66	+52 40 58.2	-3.9	15.7-20.0	—	3	328	—	—	—	MN Lac
18abtffxi	22 24 43.46	+50 31 39.1	-5.8	13.4-17.3	1.05 ± 0.14	SOB	41	—	—	—	MR Lac
18abccqjx	22 43 40.73	+30 55 20.0	-24.4	13.7-21.0	1.36 ± 0.04	6	320	Y	Y3	—	V537 Peg

[a] AP=APO DIS, K=Keck LRIS, P=Pal 200in DBS, SD=SDSS, SM=SEDM, SP=SPRAT

[b] MOT=MASTEROT, G=Gaia, Gx=GALEX, K=Kato SH papers

Table 2. CV Candidates

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	Other Surveys[b]
18ablvaya	00 14 36.26	+50 32 39.9	-11.9	16.7-21.0	—	SOB,2	147	—	—	—	MOT,Gx,ATel5749
18abcrbtv	00 14 00.93	+59 48 02.8	-2.7	18.0-20.0	—	3	237	—	—	—	—
18abuocxn	00 17 09.52	+48 53 49.6	-13.6	15.1-21.0	—	SOB	92	—	—	—	—
18abgjgyt	00 20 09.52	+51 19 13.0	-11.2	17.6-20.6	—	4	235	—	—	—	—
18abgrzbs	00 33 03.96	+38 01 05.3	-24.7	16.0-20.8	1.48 ± 0.19	3	226	Y	Y7	—	AT2016dtx
17aabumcd	00 34 17.70	+43 45 39.3	-19.0	17.4-21.0	—	SOB	154	—	—	—	—
18aczower	00 34 59.91	+27 36 19.0	-35.1	18.3-20.4	0.66 ± 0.11	3	264	Y	Y2	SDe	—
18accbuhi	00 36 15.24	+38 51 31.8	-23.9	18.5-23.0	—	SOB	36	Y	Y2	SP	PTF
18abmntn	00 47 50.31	+58 32 01.8	-4.3	16.0-20.0	—	2	182	—	—	—	—
17aaaeefu	00 59 43.51	+64 54 42.2	2.1	16.3-18.7	1.32 ± 0.07	6	250	—	—	—	—
18abgtrkj	01 12 37.73	+61 27 35.4	-1.3	16.2-20.1	1.10 ± 0.19	1 SOB	200	—	—	—	—
18abvytad	01 14 17.73	+59 35 54.7	-3.1	17.3-21.0	—	SOB	41	—	—	—	—
18abumrmx	01 15 16.55	+24 55 30.1	-37.6	16.6-19.5	—	2	300	Y	Y3	SDe	—
18abflqfh	01 17 12.39	+58 28 04.3	-4.2	16.5-19.6	—	8	234	—	—	—	—
17aaaruaj	01 28 36.51	+53 28 29.3	-9.0	18.0-21.0	—	7	233	—	—	—	MOT,Gx,ATel5395
18abzbknn	01 32 37.26	+60 36 09.3	-1.9	18.0-21.0	—	2	152	—	—	—	—
18abqasii	01 34 38.24	+52 06 15.9	-10.2	16.1-20.5	—	3	185	Y	—	—	—
18aabfagc	02 02 31.50	+56 23 38.9	-5.1	16.2-20.0	0.69 ± 0.14	8	228	—	—	—	—
18abtlqub	02 04 58.23	+57 28 06.9	-4.0	17.6-20.0	—	Nova?	54	—	—	—	—
17aaatlsc	02 14 12.97	+52 25 56.8	-8.4	18.3-20.7	0.73 ± 0.04	6	341	—	—	—	—
18ablwmaq	02 45 43.60	+63 16 48.7	3.2	17.3-20.1	—	3	224	—	—	—	—
18abtmqvh	03 32 24.87	+53 36 17.3	-2.1	16.5-20.0	—	2	207	—	—	—	—
18acsjgoa	03 42 46.18	+33 42 43.2	-16.8	17.7-20.5	—	2	122	—	Y3	—	—
18adarypz	04 01 17.42	+28 39 41.7	-18.0	16.9-20.5	—	SOB	45	—	Y1	—	—
18acuwgij	04 02 14.23	+22 08 35.5	-22.5	17.5-21.0	2.19 ± 0.58	1	30	—	Y2	Pe	AT2018jrm
19aactcry	04 03 41.03	+47 56 26.4	-3.4	18.7-20.2	—	SOB	47	—	—	—	—

Table 2 continued on next page

Table 2 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	Other Surveys[b]
18aabffpk	04 22 15.21	+29 47 58.5	-14.0	17.7-20.2	—	6	171	Y	Y3	APe	—
18aaadvfu	04 28 37.10	+31 57 57.7	-11.5	17.5-20.8	—	5	131	—	Y2	—	—
18achqmhh	04 29 47.30	+18 47 48.4	-20.0	17.9-20.1	—	SOB	55	—	—	APe	AT2018ild
18acsjdxo	04 39 16.69	+15 26 33.6	-20.3	18.3-19.6	—	1	29	—	Y2	SPe	AT2018jkg
17aaaaqee	04 43 17.84	+54 02 27.6	5.3	16.7-21.0	0.248 ± 0.04	1	14	—	—	—	—
17aactzul	04 51 22.36	+16 10 19.5	-17.5	18.8-20.8	—	1	11	—	—	Ke	—
18aaadvfh	04 55 27.72	+38 58 59.0	-2.8	18.0-20.5	—	3	157	—	—	—	—
18abvlkyj	04 56 44.78	+50 45 32.8	4.8	18.0-21.0	—	Nova?	42	—	—	—	G
17aaabekg	05 04 28.06	+44 46 37.5	2.1	17.6-20.2	—	4	251	—	—	—	—
18abuafzd	05 21 55.88	+38 52 15.1	1.3	16.0-21.0	—	1	85	—	—	—	—
17aaatnzw	05 24 04.39	+37 04 06.2	0.6	16.2-20.3	—	3	227	—	—	—	—
18abvtosb	05 28 55.68	+36 18 38.8	1.0	15.9-20.9	—	1	222	—	—	—	CBET
17aabdvhz	05 37 31.70	+50 15 21.4	9.8	17.5-19.0	—	4	226	—	—	—	—
17aaczwtq	05 53 33.12	+24 42 33.0	-0.7	17.3-20.7	—	2	97	—	—	—	—
17aaatdec	06 13 32.17	+06 57 07.6	-5.2	17.2-20.6	—	7	201	Y	—	—	—
18abyyhsf	06 16 00.22	+21 22 29.9	2.2	18.1-20.0	6.61 ± 0.11	1	31	—	—	—	—
17aadbpoq	06 18 09.21	+27 38 24.4	5.6	15.6-20.0	–	SOB,3	411	—	—	—	—
17aacpcfj	06 19 52.22	+24 20 58.6	4.4	15.1-18.9	—	1	71	Y	—	—	—
18aaaanuc	06 21 23.26	+19 13 00.3	2.3	16.5-19.8	—	3	217	—	—	—	G
18aabtvzf	06 26 22.62	+19 46 32.6	3.6	16.6-20.6	—	3	469	—	—	—	—
17aabyrom	06 29 54.23	+25 39 11.8	7.0	16.2-20.9	—	3	336	Y	—	—	MOT,ATel6027
17aacmlmj	06 31 27.16	+22 12 26.7	5.8	17.6-20.6	—	SOB	39	—	—	—	—
18abypyap	06 31 45.99	+09 54 45.2	0.2	16.8-20.1	—	2	109	Y	—	—	—
18abztcib	06 33 30.75	+59 18 47.8	20.9	15.5-20.8	0.37 ± 0.07	2	218	—	—	SM	AT2018gxm
19aakmorl	06 37 33.01	-09 35 42.1	-7.4	11.3-17.8	2.72 ± 0.44	1	79	—	—	—	—
18achtpcj	06 41 21.30	+44 41 05.6	17.0	17.3-20.2	2.51 ± 0.56	SOB	36	Y	—	—	AT2018ila
17aaaoxxi	06 49 01.96	+08 59 44.6	3.6	16.6-20.1	—	5	449	—	—	—	—
17aabziqr	06 52 13.34	+30 57 22.2	13.7	15.7-21.0	—	6	545	—	—	—	—
19aaekpin	06 54 04.39	-09 41 03.5	-3.8	16.3-20.5	—	SOB	59	—	—	—	AT2019awv,ROSAT,G

Table 2 continued on next page

Table 2 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	Other Surveys[b]
18acphaci	06 55 50.84	-09 32 37.6	-3.4	17.5-20.6	—	6	150	—	—	—	—
18acuxkzq	07 04 37.59	+06 01 13.3	5.7	17.6-20.0	—	SOB	36	—	—	—	AT2018jii
18acpvmnu	07 07 35.97	-09 12 41.7	-0.6	15.02-20.5	1.82 ± 0.51	2	67	—	—	—	AT2018itx
18acnnxrd	07 11 28.27	-03 26 15.0	2.9	16.5-20.0	—	SOB,1	117	—	—	SM	—
18acuxvld	07 15 12.98	-06 42 38.3	2.2	14.6-19.0	—	SOB	31	—	—	—	—
18acvvthl	07 49 40.33	+07 16 56.0	16.2	17.3-19.9	—	1	16	Y	—	—	MOT
18acqxeba	08 03 16.61	+66 11 10.0	31.9	15.0-17.9	0.87 ± 0.25	1	153	Y	—	—	G
18aabuaxp	08 19 31.24	+21 33 38.0	28.5	17.4-20.2	—	3	508	Y	Y6	SMe	—
18aabjjuj	09 11 47.01	+31 51 01.8	42.5	14.8-20.5	—	SOB,1	134	Y	Y4	—	
18acnocdo	09 14 42.69	+67 10 36.9	38.5	15.0-20.1	1.12 ± 0.33	SOB	181	Y	Y	APe	G
18aczejci	09 26 20.42	+03 45 42.4	35.8	17.6-20.5	—	6	144	Y	Y2	—	—
18aabywzu	10 37 38.65	+12 42 50.1	55.6	16.6-20.3	4.77 ± 0.05	1	84	—	Y2	SMe	AT2016ags,G
17aaclmhw	10 53 33.76	+28 50 35.7	64.0	17.9-19.9	1.27 ± 0.45	3	111	Y	—	K	—
19aacyjjz	11 10 18.95	-05 22 18.4	49.3	16.4-20.0	—	1	171	—	Y2	—	ATel1272
18aaqepuc	11 37 08.67	+51 34 50.9	61.8	17.4-20.8	—	3	375	Y	Y4	—	G
18abbghiz	12 56 09.84	+62 37 04.4	54.5	16.5-21.5	—	SOB	43	Y	—	—	MOT,ATel8846
18aabqewr	12 58 32.20	+26 01 06.30	88.1	16.0-21.0	—	1	511	Y	—	—	ASASSN-18cr
18aabxycb	13 15 14.42	+42 47 44.6	73.6	16.9-20.5	—	9	511	Y	Y8	APe	PTF
18aajlfdq	13 56 42.38	+61 30 24.4	53.9	16.4-21.4	—	HL	387	Y	—	—	ASASSN-13ap,ATel5118
18aawqkva	15 44 28.10	+33 57 26.4	52.4	17.1-24.0	—	3	410	Y	Y2	—	AT2018fhi,PTF
18aavojbe	15 46 52.71	+37 54 14.9	51.9	16.0-21.1	—	2	350	Y	Y4	—	PTF
18abklaip	15 50 30.38	-00 14 17.4	39.0	18.1-19.5	—	2	275	Y	Y2	—	—
18aakuohk	16 17 00.94	+62 00 24.6	41.6	14.7-20.5	2.03 ± 0.08	10	384	Y	Y2	—	PTF,G
18abagclj	16 26 05.66	+22 50 43.5	41.5	18.3-20.6	0.92 ± 0.13	SOB, 1	356	Y	Y3	—	CRTS
18aakvnlw	16 47 48.00	+43 38 45.0	40.2	19.4-20.4	—	7	174	—	Y1	—	—
18abkikam	17 04 44.51	+26 20 28.5	34.1	19.5-20.7	—	1	31	Y	—	SM,Ke	—
18aaisdps	17 05 15.33	+72 44 03.2	33.6	16.5-20.8	—	6	309	Y	—	—	MOT
18abpaake	17 06 06.10	+25 51 53.2	33.7	16.4-20.3	1.23 ± 0.03	1	32	Y	—	—	—
19aagdvdi	17 11 38.40	+05 39 50.9	24.7	15.2-20.1	—	2	106	—	—	—	PTF,AT2019ath

Table 2 continued on next page

Table 2 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	Other Surveys[b]
18abeechv	17 16 02.90	+29 27 36.5	32.5	18.8-20.0	—	SOB	45	Y	—	Pe	—
18abfwukx	17 26 24.11	+36 25 06.3	32.0	19.2-21.0	—	1	37	—	—	Ke	AT2018eky
19aanvbqa	17 27 50.17	+23 52 47.5	28.4	14.8-20.0	1.28 ± 0.03	SOB	64	Y	—	—	AT2019cni
18aapqotx	17 32 30.30	+50 09 32.6	32.9	17.5-20.0	—	2SOB	385	—	Y2	—	PTF
18aanihlw	17 44 26.27	+42 19 15.1	29.8	15.7-19.5	0.57 ± 0.02	2	113	—	Y1	—	—
18aakzqjh	17 46 48.85	+19 47 44.5	22.8	18.0-21.0	—	10	360	Y	Y2	—	—
18aaploaw	17 47 25.61	+63 02 47.9	31.2	18.0-20.4	—	3	409	Y	—	—	AT2018eeb,ATLAS18spw
18aajrtmo	17 48 27.86	+50 50 39.7	30.4	14.9-20.5	1.35 ± 0.25	5	408	Y	Y1	—	ASASSN-13ak,PTF
18abckxfb	17 49 21.78	+19 44 22.9	22.2	18.4-21.0	—	SOB	47	—	—	SM	AT2016cya
18abffzyg	17 52 38.47	+07 33 04.5	16.5	15.8-20.5	—	4	261	—	—	—	V982 Oph
18abfmuvj	17 53 30.49	+20 38 07.1	21.7	17.8-21.0	0.22 ± 0.05	2	329	—	—	SM	AT2018dyr
18aasfpxf	17 56 33.39	+57 29 26.6	29.9	17.5-21.0	—	2	384	Y	—	—	—
18aabtvdf	17 56 39.55	+44 40 12.4	28.1	15.3-21.0	0.72 ± 0.05	22	426	—	—	—	—
18aaumvgk	18 00 18.30	+15 15 28.4	18.1	16.5-20.0	—	1	279	—	—	SM,APe	MOT,AT2018bsp,ATEL9204
18aapauoa	18 00 43.08	+21 01 34.2	20.2	17.0-20.6	—	6	382	—	—	APe	—
18aagrotg	18 02 31.35	+30 38 29.1	23.2	16.6-21.0	—	5	388	—	—	—	—
18abcmsux	18 03 24.75	+17 52 31.6	18.4	18.2-21.0	—	2SOB,1	315	—	—	—	AT2018fpf
18aaniudh	18 09 47.90	+30 23 05.7	21.7	17.3-20.0	0.84 ± 0.03	5	379	—	Y2	—	—
18aayzgkc	18 10 20.64	+32 39 13.8	22.3	16.4-22.0	0.84 ± 0.23	SOB	73	—	—	SM,APe	—
18abjvmhv	18 15 27.34	+41 56 05.3	24.1	13.8-21.0	—	SOB	299	Y	—	—	—
18aaptdcp	18 21 22.52	+61 48 55.2	27.2	14.3-21.1	1.15 ± 0.29	3	373	—	—	—	ASASSN-13at
18aaqznkg	18 29 13.38	+31 06 23.6	18.0	19.5-21.8	—	1	9	—	—	SM,Ke	MOT
19aaedxnl	18 30 07.21	+76 43 13.8	27.6	16.2-20.5	—	2	114	—	—	—	MOT,ATel4843
18aakytes	18 31 20.68	+30 19 34.9	17.3	16.1-21.0	—	5	390	—	—	—	MOT,ATel4761
18abfgyjt	18 34 59.52	+54 33 15.0	24.1	17.9-21.0	—	2	31	—	—	Pe	—
18abdklug	18 37 05.92	+37 17 58.8	18.7	18.5-20.0	—	2	336	—	—	—	AT2018haz
18aatzhmn	18 41 51.05	+37 52 28.6	18.0	14.3-20.0	0.13 ± 0.03	1 SOB	78	—	—	—	AT2018blk
18aaracvu	18 41 59.71	+37 34 11.6	17.9	17.8-20.0	—	SOB,6	106	—	—	K,APe	AT2018bit
18acdwdgx	18 42 51.29	+33 56 49.5	16.4	16.8-19.8	—	1	30	—	—	—	—

Table 2 continued on next page

Table 2 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	Other Surveys[b]
18aammzjo	18 44 26.89	+36 51 40.2	17.2	17.8-20.6	—	12	410	—	—	—	MOT,ATel6003
18aavyoqk	18 45 02.01	+13 55 17.6	7.7	14.9-18.9	—		350	—	—	—	ROSAT,RXSJ
18abfxhyn	18 46 12.88	+12 52 29.0	7.0	17.2-20.8	—	SOB	328	—	—	—	MOT
18abcysbr	18 48 43.45	+29 54 51.1	13.7	16.4-19.0	—	SOB,2	279	—	—	—	MOT
18abixdpa	18 50 22.30	+74 56 02.5	26.2	17.1-20.4	0.46 ± 0.09	3	304	—	—	—	—
18aawadah	18 52 16.40	+15 06 23.5	2.1	16.4-20.5	—	3	377	—	—	—	—
18abbtilo	18 57 44.62	+32 13 46.5	12.9	18.3-21.0	2.59 ± 1.09	SOB	38	—	—	APe	PTF
18aaovfjr	18 58 11.15	+46 27 56.5	18.2	15.4-20.4	1.42 ± 0.28	6	376	—	Y1	—	AT2017dac
18abqazwf	19 00 32.27	+30 30 40.0	11.6	17.9-20.0	—	2	270	—	—	Pe	—
18aaraifg	19 00 58.43	+30 35 47.5	11.6	17.6-21.0	—	SOB,1	33	—	—	SM,Pe	AT2018bhy
18accntcd	19 01 04.62	+45 05 16.0	17.2	17.1-21.0	0.67 ± 0.07	1 SOB,1	201	—	—	—	AT2018ijr
18aapuklg	19 03 42.18	+53 47 45.8	19.8	15.3-21.0	0.99 ± 0.15	1SOB,11	378	—	Y6	—	—
18abjkhgu	19 05 16.00	+47 23 34.5	17.4	17.1-20.7	—	SOB	288	—	—	—	MOT,Atel9104
18abciqza	19 08 12.64	+04 57 28.0	-1.5	17.3-20.1	0.88 ± 0.14	3	319	—	—	—	—
18aavesgh	19 14 04.90	+47 25 10.0	16.0	16.1-20.7	—	2	374	—	—	—	—
18ablxvvr	19 18 37.82	+22 26 07.0	4.4	15.5-20.0	—	Nova?	30	—	—	—	G
18aayupbw	19 20 30.90	+27 43 33.1	6.5	17.4-21.0	—	1	280	—	—	—	—
18aapsxwc	19 20 58.71	+45 06 37.6	14.0	18.2-20.0	—	6	373	—	—	—	—
18aasnlwa	19 22 34.05	+27 32 01.1	6.0	16.5-20.9		7	371	—	—	—	—
18abkhgfg	19 26 33.86	+16 02 20.3	-0.3	16.9-20.3	0.53 ± 0.06	SOB	42	Y	—	—	AT2016hkw
18aayncoh	19 27 57.59	+46 43 32.3	13.6	17.6-20.8	—	4	367	—	—	—	—
18abdeelv	19 30 59.19	+51 57 35.2	15.4	14.8-22.0	—	SOB	327	—	—	—	ASASSN-14fu,ATel6761
18aauegwi	19 32 03.61	+45 07 59.16	12.3	16.0-20.0	1.14 ± 0.14	5	373	—	—	—	—
18abptyvl	19 35 57.46	+11 05 28.2	-4.6	15.6-20.8	1.38 ± 0.43	2	282	—	—	—	—
18abdkwtr	19 35 57.54	+33 00 49.4	6.0	18.4-20.0	—	3	322	—	—	—	G
18abbctvx	19 36 02.88	+46 08 31.2	12.1	17.1-20.0	—	1	31	—	—	SM	—
18abdiirq	19 41 04.86	+31 57 47.7	4.5	15.4-21.0	0.71 ± 0.06	8	309	—	—	—	—
18aaynycd	19 42 30.55	+36 01 19.3	6.3	18.3-20.1	—	SOB	39	Y	—	SM	—
18aazvbyj	19 43 32.98	+16 31 06.8	-3.6	17.5-19.5	—	5	319	—	—	—	—

Table 2 continued on next page

Table 2 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	Other Surveys[b]
18abdkpol	19 43 41.51	+43 39 11.9	9.7	18.2-20.5	—	2	114	—	—	—	—
18aaptabw	19 47 30.06	+48 09 17.6	11.3	16.1-21.2	—	3	358	—	—	—	PTF
18abojqbk	19 47 30.70	+25 43 31.9	0.2	15.5-20.7	—	3	281	—	—	—	G
18abfhssx	19 48 26.68	+59 33 10.3	16.4	19.0-21.0	—	2	145	—	—	SM	ROSAT,XMM
18aauebur	19 48 49.10	+46 30 36.1	10.3	18.5-21.0	0.32 ± 0.04	SOB,4	193	—	—	SM	AT2018epr
18ablxhlc	19 48 58.30	+58 26 20.9	15.8	18.2-21.0	—	SOB	300	—	—	—	G
18abmfxml	19 50 42.77	+08 25 45.3	-9.1	16.8-19.7	—	6	265	—	—	—	—
18abchfow	19 50 38.85	+21 16 51.8	-2.7	18.6-21.0	—	3	349	—	—	—	—
18aavzkpp	19 50 54.38	+35 51 35.9	4.7	17.7-21.0	—	3	211	Y	—	—	AT2019bcl
18aazfbvg	19 54 46.08	+18 37 37.3	-4.8	16.2-17.6	—	8	330	—	—	APe	PTF
18aaypfws	19 55 37.25	+23 35 57.9	-2.5	19.0-21.0	—	4	349	—	—	—	—
18aayeczt	19 57 12.21	+18 49 41.0	-5.2	16.5-19.0	—	2	174	—	—	—	—
18abvokyy	19 57 15.07	+36 27 03.3	3.9	18.0-21.0	—	2	89	—	—	—	—
18aawlljc	20 03 34.02	+29 34 36.7	-0.8	17.4-20.7	—	2	369	—	—	SM	AT2018ccf
18abmhjpr	20 04 07.64	+12 26 18.4	-10.0	16.4-19.5	0.99 ± 0.22	5	272	Y	—	—	—
18abnudvw	20 04 20.95	+11 32 47.2	-10.5	18.5-20.0	—	4	268	Y	—	—	AT2016diu
18acyjvhm	20 06 16.59	+07 38 15.4	-12.8	15.9-19.8	0.24 ± 0.04	SOB	18	—	—	—	—
18absihoy	20 07 42.61	+11 58 10.4	-10.9	16.5-20.0	—	2	140	—	—	—	—
18abudsie	20 07 44.61	+00 27 50.1	-16.7	18.2-19.8	—	3	1391	Y	—	—	—
18abaqnny	20 09 22.90	+59 13 48.1	13.9	19.2-24.0	—	2	70	Y	—	K	—
18aayukga	20 10 02.01	+37 06 15.4	2.1	17.5-20.8	0.42 ± 0.12	6	329	—	—	—	—
18aaxyrau	20 10 53.41	+44 10 46.3	5.8	17.4-19.7	—	SOB,5	338	—	—	—	MOT,ATel4611
18aawluad	20 12 25.84	+23 36 20.9	-5.7	18.5-21.0	—	3	348	—	—	—	—
18abnuekr	20 13 55.88	-05 26 06.1	-20.8	17.2-19.5	—	3	259	—	—	—	G
18aayeosh	20 26 23.46	+32 01 08.4	-3.6	15.7-21.0	0.91 ± 0.27	5	346	—	—	—	—
18aazffjy	20 28 36.83	+56 13 46.3	10.1	18.2-21.0	—	SOB,4	342	—	—	SM	—
18abajlni	20 32 32.12	+58 09 28.8	10.8	16.7-21.0	1.36 ± 0.11	SOB,2	286	Y	—	SM	—
18aaxprrt	20 36 39.95	+47 02 15.8	3.7	17.8-21.0	—	3	316	—	—	—	—
18acbwqtc	20 40 44.21	+50 59 40.2	5.6	16.0-21.0	—	SOB	39	—	—	—	—

Table 2 continued on next page

Table 2 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	Other Surveys[b]
18abikzev	20 41 30.41	+48 13 33.0	3.8	18.6-20.5	—	3	319	—	—	—	—
18abdhxvl	20 43 59.58	+42 03 25.4	-0.4	16.8-19.5	1.49 ± 0.45	6	535	Y	—	—	AT2016dvk,G
18abxkbzz	20 44 28.70	+14 50 11.3	-16.9	18.4-21.0	—	SOB	39	Y	—	SM	AT2018grl
18abzvpif	20 49 51.90	+46 19 50.2	1.5	18.5-20.5	—	1	249	—	—	—	—
18abjwsby	20 59 15.71	+43 01 07.2	-1.9	17.4-20.0	0.45 ± 0.12	3	308	—	—	—	—
18aazeyze	21 04 35.46	+15 05 01.4	-20.7	18.0-20.3	—	4	329	—	—	—	—
18abmarba	21 21 08.93	+30 34 14.3	-13.5	16.0-20.8	—	2	287	—	—	—	—
17aaaejau	21 21 28.58	+29 15 41.2	-14.5	17.5-20.7	—	5	293	—	—	—	AT2018kgn
18absanfq	21 23 05.54	+15 08 48.6	-24.1	17.8-21.0	0.60 ± 0.06	1	42	—	—	SM	AT2018fpd
18aayoxjs	21 25 43.95	+63 23 18.0	9.2	17.6-19.9	—	SOB,5	334	—	—	SM	AT2018efi
18abihypg	21 28 22.20	+63 25 57.2	9.0	15.0-20.0	—	6	320	—	—	—	—
18abvigco	21 29 59.49	+78 52 21.5	19.7	14.8-20.0	1.89 ± 0.32	SOB	45	—	—	—	—
18abwntpz	21 34 37.09	+57 02 07.3	3.8	14.9-20.6	—	SOB	220	—	—	—	—
18abaphmn	21 38 25.68	+27 30 36.0	-18.4	18.9-21.0	2.70 ± 0.13	SOB	102	Y	—	—	AT2016fvd
18abjtach	21 43 32.98	+46 12 22.3	-5.2	16.7-20.5	—	SOB	33	—	—	—	—
17aadsnyp	21 43 33.57	+51 20 03.7	-1.3	16.9-20.9	0.52 ± 0.13	7	331	—	—	—	—
17aaarine	21 46 48.25	+48 27 47.5	-3.9	18.1-21.0	0.41 ± 0.06	2 SOB	122	Y	—	—	AT2016jbf
18abnxgmb	21 48 07.80	+29 38 48.0	-18.3	16.4-21.0	—	SOB	163	—	—	—	—
18abochac	21 51 25.83	+46 28 03.5	-5.9	18.2-22.0	—	2	174	Y	—	—	—
18abvxdou	21 52 32.31	+49 04 19.4	-4.0	16.7-21.0	—	SOB,1	263	—	—	—	AT2018glg
17aabutiy	21 58 15.94	+51 50 20.3	-2.4	17.4-19.8	—	3	336	—	—	—	—
18abvbqyo	22 06 41.05	+30 14 35.8	-20.4	18.4-21.0	—	2	234	Y	Y1	SM	AT2016jai
17aaawrkt	22 11 43.22	+52 14 33.3	-3.3	17.0-20.0	0.83 ± 0.07	12	330	—	—	—	—
18ablxvvr	22 17 31.66	+46 59 32.9	-8.2	14.7-20.7	—	2	30	—	—	—	ROSAT
18ablvntg	22 27 07.17	+55 37 60	-1.7	15.2-20.6	1.60 ± 0.39	1	41	—	—	SMe	—
18abqboud	22 31 23.00	+33 30 57.1	-20.6	15.5-21.0	0.33 ± 0.05	SOB	108	—	—	SM	AT2018frz
18abblwnw	22 45 00.98	+56 31 30.6	-2.2	16.8-20.3	1.27 ± 0.34	4	328	—	—	—	—
18abmnmuw	22 47 51.45	+36 43 19.3	-19.8	15.7-20.4	—	1	1132	Y3	—	—	MOT,ATel7438
18acehgym	22 48 25.99	+38 55 09.6	-18.0	19.2-23.0	—	2	1588	—	—	SM,Ke	AT2018hgz

Table 2 continued on next page

Table 2 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec[a]	Other Surveys[b]
18abccwds	22 52 31.58	+59 11 35.1	-0.2	18.9-21.0	—	4	364	—	—	—	—
18abmnmvz	22 53 50.55	+33 30 32.4	-23.3	16.2-20.2	—	3	159	Y	Y2	—	ASASSN-13by
18ablvjse	22 56 32.43	+35 42 38.4	-21.6	17.0-21.0	—	3	297	—	Y2	APe	MOT
18abcxmen	22 56 57.90	+55 53 41.6	-3.5	17.6-21.0	—	7	197	—	—	—	—
18aaypqid	23 05 38.42	+65 21 58.6	4.7	14.7-20.5	1.62 ± 0.23	1	332	—	—	—	ROSAT
18aazndjw	23 10 11.15	+51 15 11.07	-8.5	17.2-20.5	—	SOB,4	329	—	—	SM	ATel11797,AT2018ctl,ROSAT,G
18aazwddf	23 24 04.01	+51 43 18.0	-8.8	17.3-21.4	—	4	328	Y	—	—	—
17aabunmx	23 34 35.56	+54 33 25.5	-6.7	15.7-20.5	1.19 ± 0.19	SOB,3	225	—	—	—	AT2018asi
18abvxbfh	23 35 30.00	+60 54 05.7	-0.6	17.4-20.3	—	1	52	—	—	—	—
17aabuvei	23 36 46.10	+57 57 24.1	-3.5	17.7-20.0	—	7	231	—	—	—	—
18abcpbbj	23 37 27.57	+51 13 58.7	-10.0	16.7-21.0	1.71 ± 0.33	3	206	—	—	—	—
18abjmxql	23 38 43.54	+57 17 19.9	-4.2	15.2-20.4	1.29 ± 0.32	2	143	Y	—	—	—
18abiwzlg	23 52 01.18	+44 50 58.2	-16.8	15.2-20.4	1.60 ± 0.26	SOB,1	178	—	Y1	—	AT2016
17aaaedem	23 54 58.53	+54 27 29.3	-7.5	17.0-21.0	—	SOB,5	205	—	—	—	—
18abgtjea	23 59 33.64	+56 05 01.5	-6.1	17.6-21.0	—	SOB	65	—	—	—	AT2018eoi,PS1,ATLAS

[a] AP=APO DIS,K=Keck LRIS,P=Pal 200in,DBS,SD=SDSS,SM=SEDM,SP=SPRAT

[b] MOT=MASTEROT,G=Gaia,Gx=GALEX

Table 3. Possible Candidates

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec	Surveys
18abhypsw	00 52 09.61	+43 56 20.1	-18.9	17.0-20.0	0.50 ± 0.07	2	49	Y	Y2	—	ROSAT,G
18acyqzew	01 43 54.23	+29 01 03.8	-32.5	15.8-19.0	1.86 ± 0.11	1	42	Y	Y2	—	G
18aabfbek	02 45 07.91	+46 32 60	-12.0	16.1-19.9	—	2	37	Y	—	—	G
18abppgdj	03 28 15.91	+61 25 17.2	4.0	14.2-20.5	4.09 ± 0.15	1	219	—	—	—	AT2019cbz,G
18acemvzp	04 57 51.59	-06 10 38.2	-28.0	16.4-20.4	1.10 ± 0.05	1	14	—	—	—	ROSAT,G
17aaabswj	05 25 03.73	+39 33 59.1	2.2	17.6-19.6	1.69 ± 0.56	2	193	—	—	—	G
18adaifhl	05 35 45.89	-08 47 48.8	-20.8	18.6-20.0	3.15 ± 0.79	1	30	—	—	—	AT2018lu,ROSAT,G
18acxhxny	05 47 04.15	+26 45 04.0	-0.9	17.2-21.0	—	1	29	—	—	—	G
18abuqngq	06 11 25.06	+22 21 17.1	1.7	16.8-20.0	—	2	229	—	—	—	PTF,G
18acnatft	06 29 04.48	+11 25 37.5	0.3	17.8-21.0	—	1	14	—	—	—	ROSAT,G
19aakncwr	08 10 51.92	-04 04 28.5	15.6	16.4-20.2	—	1	53	—	—	—	AT2017cjw,G
18acrhioo	08 40 19.19	-03 51 24.7	22.1	17.2-19.3	—	2	35	—	—	—	ROSAT,G
19aajywdx	09 24 34.29	+08 40 31	37.9	16.2-20.7	—	1	24	Y	—	—	ROSAT,G
19aarflna	11 34 02.27	+14 01 29.3	67.7	13.6-20.0	—	1	26	Y	—	—	G
19aaqxmmw	14 58 58.58	-06 07 05.8	44.7	15.4-20.3	—	1	23	—	—	—	G
18abetcrn	17 28 03.39	+25 50 50.3	28.9	19.4-21.1	0.86 ± 0.03	2	296	—	—	P,K	G
18abltirl	18 06 56.21	+06 10 34.8	12.7	15.9-21.0	1.93 ± 0.19	2	341	—	—	—	Swift,G
18abgvtpb	18 20 59.50	-20 09 48.5	-2.7	16.7-19.6	—	1	5	—	—	—	ROSAT,G
18acaqbgu	18 34 35.96	+31 32 00.9	17.1	17.6-21.0	—	1	30	—	—	—	AT2016hrt,XMM,ROSAT,G
18ablmpfr	18 44 34.47	+13 07 17.7	7.4	19.0-21.0	—	1	30	—	—	—	G
18ablrvfh	18 47 15.37	-06 13 21.0	-1.9	16.8-19.6	—	4	273	—	—	—	ROSAT,G
18abcyzxp	19 08 59.31	+25 39 45.7	7.8	17.6-18.1	—	1	10	—	—	—	G
18abdjqmg	19 38 44.34	+35 40 31.2	6.8	17.5-19.9	0.23 ± 0.08	1	30	Y	—	—	—
19aaaaazu	20 27 03.59	+19 23 07.9	-10.9	15.4-19.4	—	SOB?	35	—	—	—	G
18absstbs	20 35 01.48	-00 19 46.4	-23.0	15.6-20.0	1.17 ± 0.25	1	263	Y	Y3	—	ASASSN-14hb,G
18accpmqr	20 55 08.85	-06 29 11.4	-30.4	17.0-19.6	0.76 ± 0.17	2	48	Y	—	—	ROSAT,G

Table 3 continued on next page

Table 3 *(continued)*

ZTF	RA	Dec	b°	Δmag	p(mas)	Out	Days	SDSS	CRTS	Spec	Surveys
18abiijne	21 38 14.01	+52 17 51.5	-0.1	16.3-21.0	0.65 ± 0.03	2	77	—	—	—	ROSAT,AT2019gya,G
18acarunx	22 14 03.77	+37 34 52.8	-15.5	17.5-20.0	1.25 ± 0.20	2	254	—	—	—	AT2018hgp,ROSAT,G
18actxlqb	22 45 05.38	+01 15 47.2	-48.4	18.4-21.6	—	1	28	Y	Y4	—	AT2018jlx,G
18abvburn	22 55 21.40	+53 38 43.8	-5.4	18.7-20.9	—	1	40	—	—	—	G

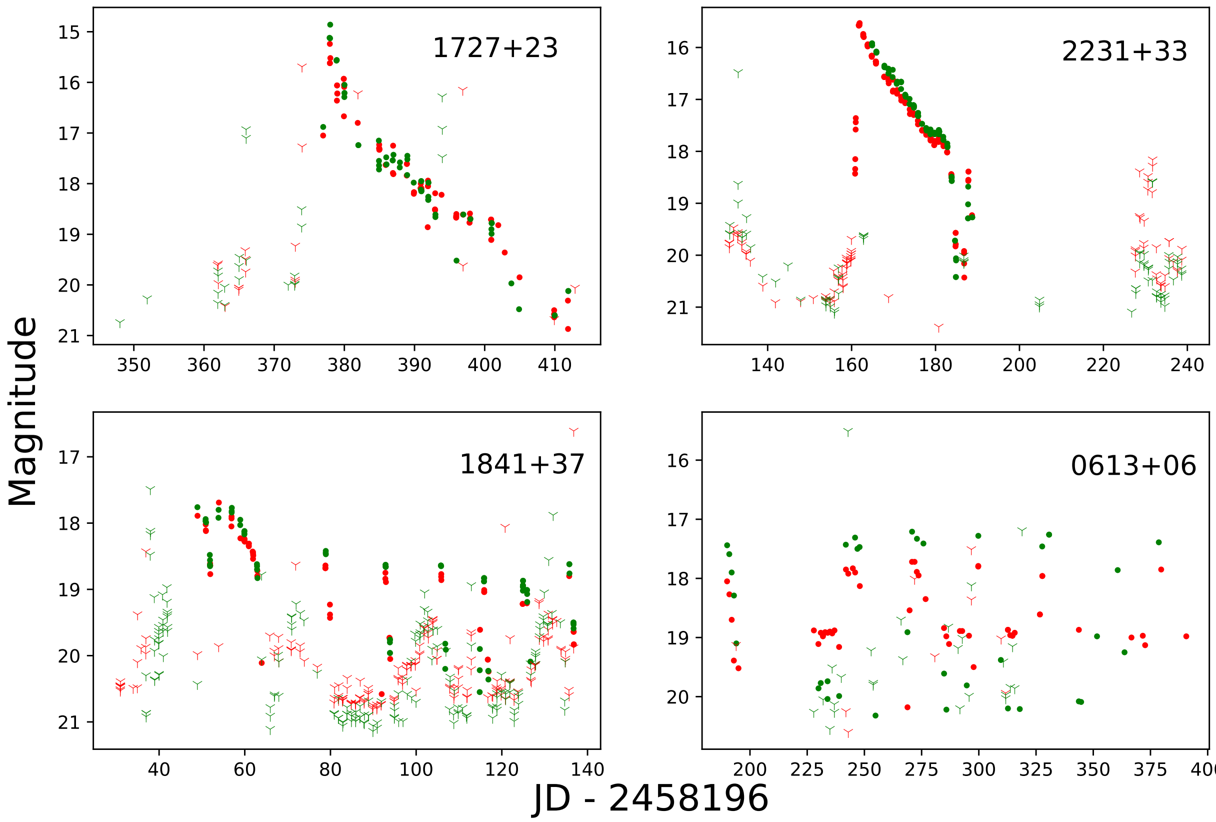

Figure 1. Examples of ZTF light curves of good CV candidates from Table 2.

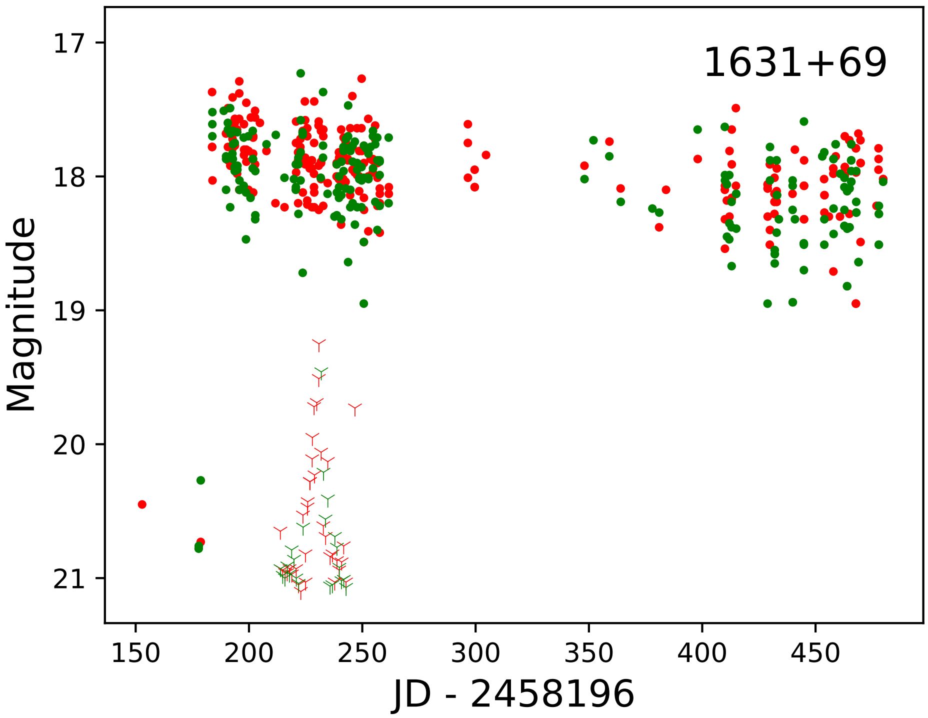

Figure 2. An example of a system showing high and low states.

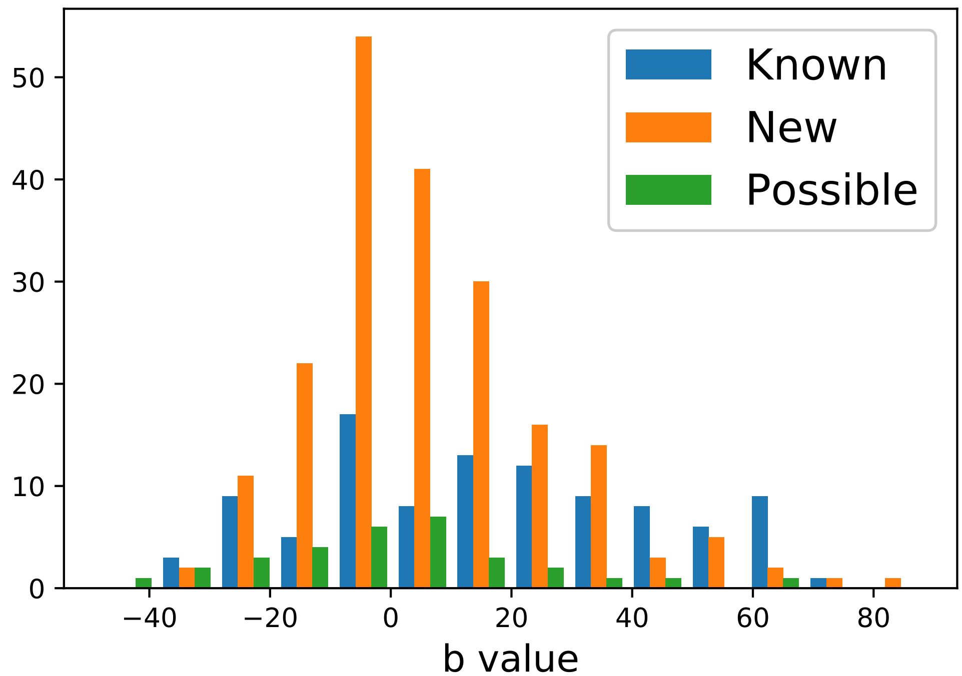

Figure 3. The number of systems in Tables 1-3 as a function of galactic latitude (in 5 deg bins).

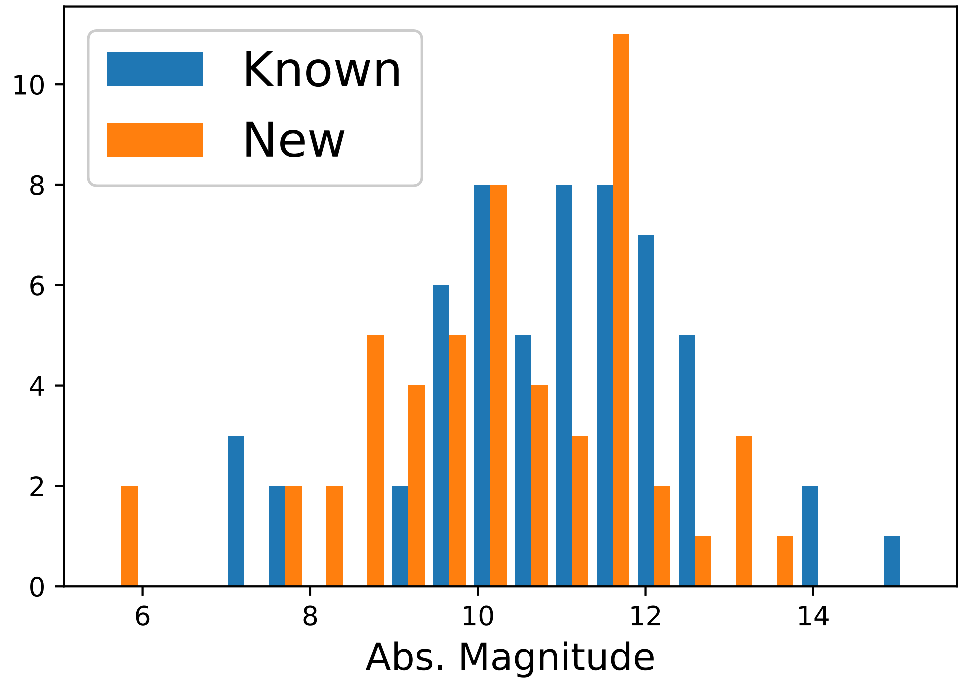

Figure 4. The number of systems in Tables 1 and 2 as a function of their absolute magnitude as determined from available Gaia parallaxes. Note that upper limits on the magnitudes for the fainter sources means that they are brighter limits to the true absolute magnitude at quiescence.

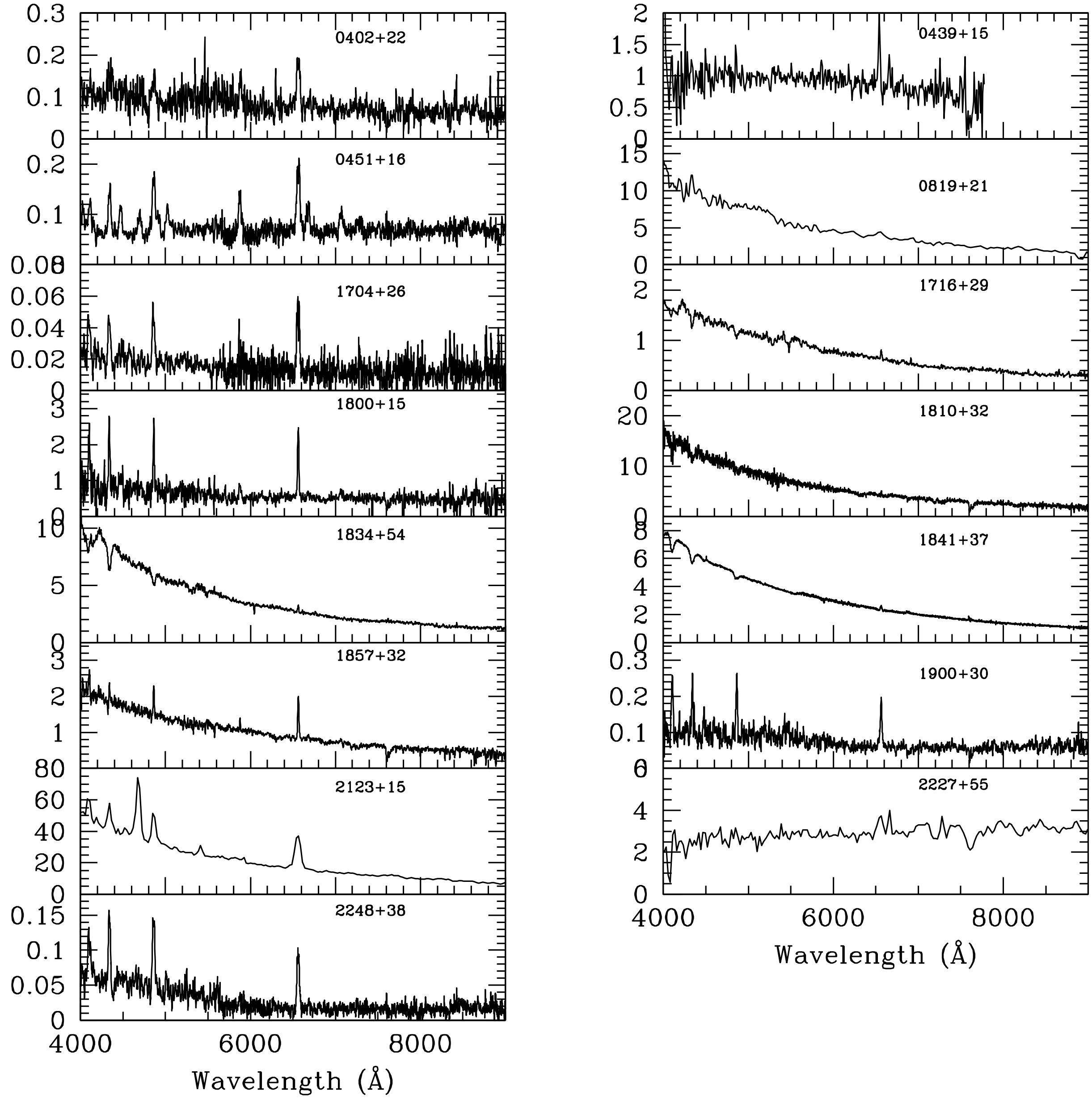

Figure 5. Emission line spectra from Keck, Pal200in, SEDM, SPRAT. The vertical axis is F_λ in units of 10^{-16} ergs cm−2 s^{-1} $Å^{-1}$ except for the SPRAT spectrum of ZTF0439+15 which is normalized in its reduction procedure.

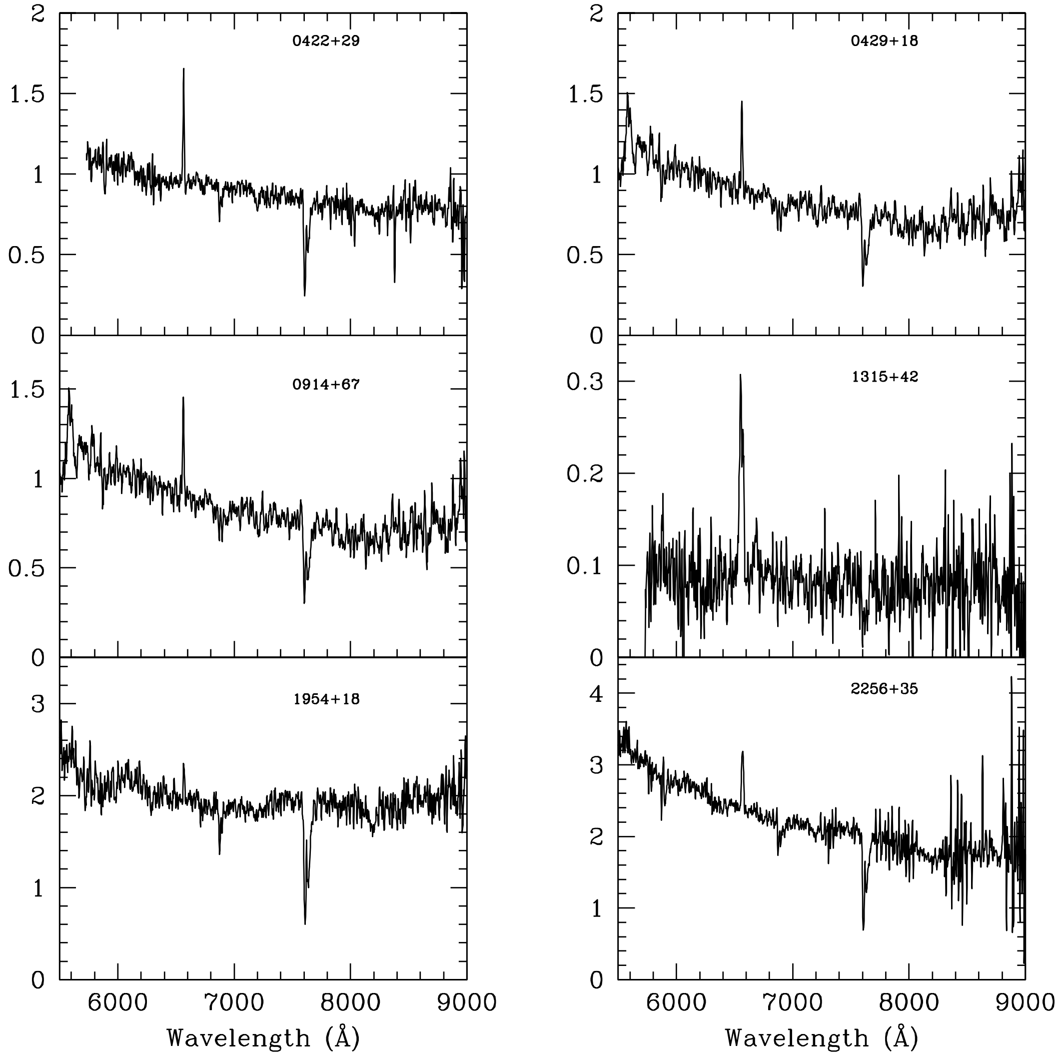

Figure 6. Red spectra obtained at APO.The vertical axis is F_λ in units of 10^{-16} ergs cm−2 s^{-1} $Å^{-1}$.

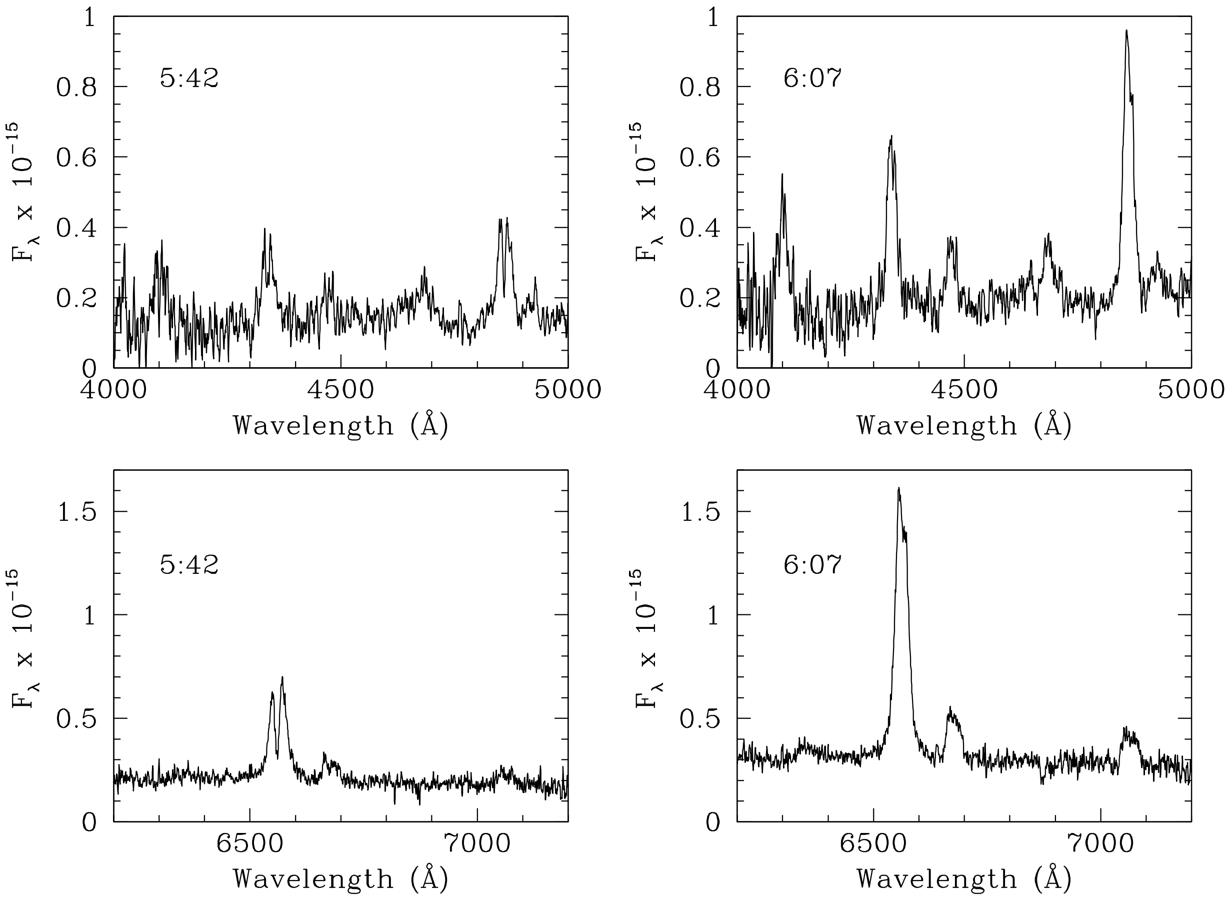

Figure 7. Two of the blue and red APO DIS spectra of 1631+69 obtained 25 min apart showing the large changes in the Balmer and He lines.

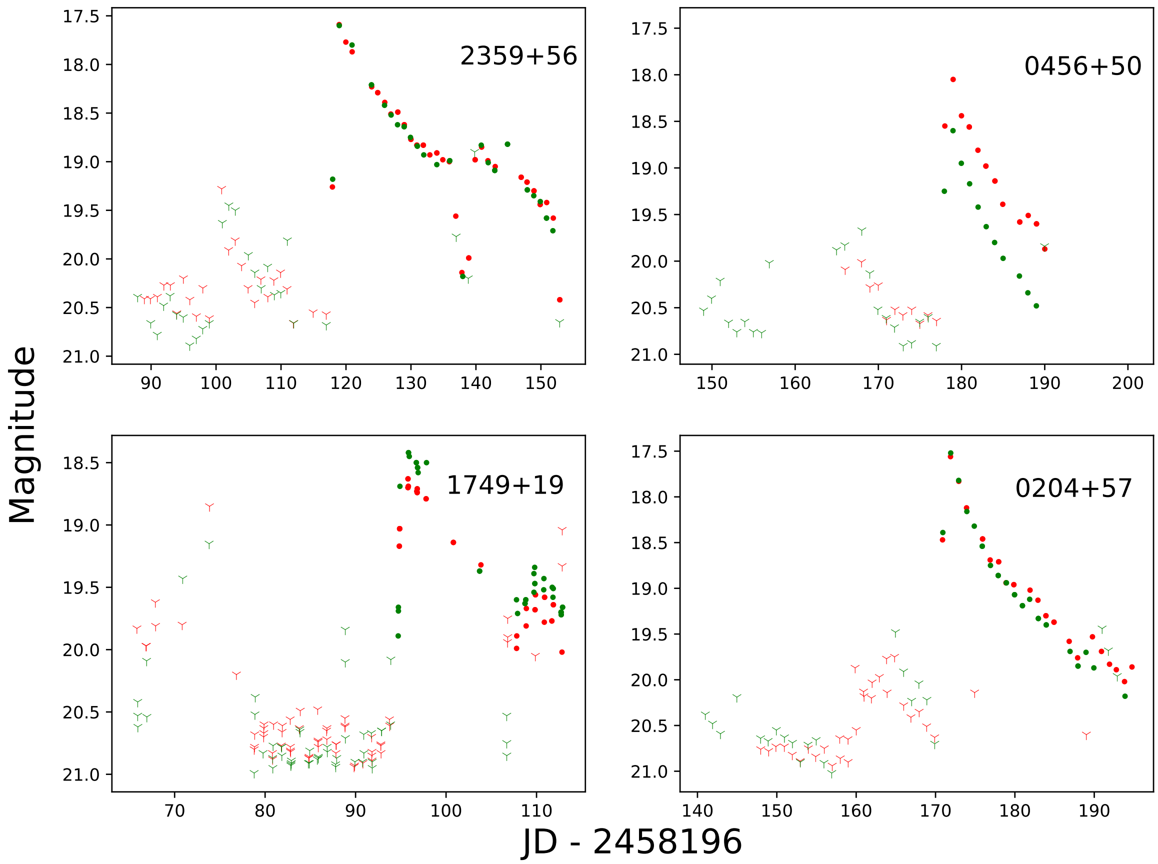

Figure 8. Some examples of systems that could be novae or dwarf novae.

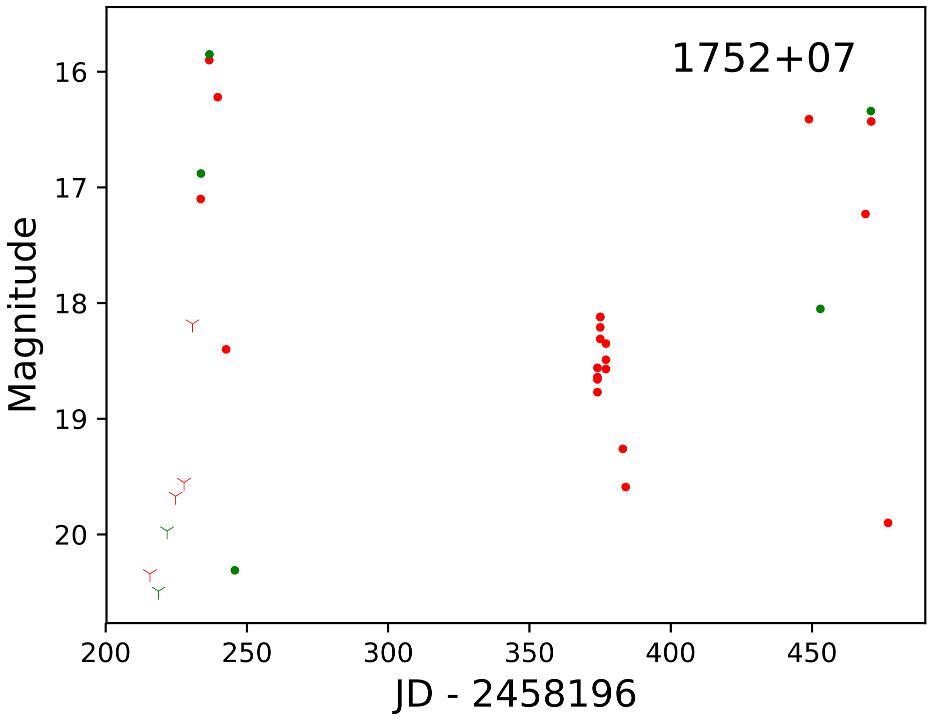

Figure 9. ZTF1752+07 (V982 Oph) light curve showing 4 dwarf nova type outburst.