Intermittent Multi-Color Photometry for V1017 Sagittarii

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Abstract *UBVRI* photoelectric photometry is presented for the dwarf nova V1017 Sgr.

1. Introduction

The star V1017 Sgr, coordinates R. A. = $18^h\ 32^m\ 04.476^s$, Dec. = –29º 23' 12.59" (J2000), originally was discovered to be variable by Ida E. Woods, as reported by Bailey (1919). They also noted a previous brightening which occurred in 1901. Additional names for V1017 Sgr include Nova Sgr 1919, HV 3519, AAVSO 1825–29, 2MASS J18320447-2923125, and UCAC4 304-232890. Kraft (1964), from 200-inch telescope spectra, reported the spectrum, which showed faint wide emission at the Balmer lines, to be that of a late-type star, with a suggested spectral type of G5 IIIp. He deduced the star to be a binary, based upon its composite spectrum. Sekiguchi (1992) described a spectroscopic orbit with a period of 5.714 days, thereby giving V1017 Sgr a long period for a star that was thought to be a dwarf or classical nova.

A broad discussion of available data was given by Webbink *et al.* (1987). Vidal and Rodgers (1974) supplied supporting detail. Schaefer (2010) deduced that V1017 Sgr was not a recurrent nova. He noted eruptions in 1901, 1919, 1973, and 1991, with only the 1919 eruption of size to be designated a nova event. The other increases in brightness were identified as representing a dwarf nova. Pagnotta and Schaefer (2014) reiterated that the brightest eruption was typical of a classical nova, whereas all other brightenings resembled dwarf nova eruptions.

Downes et al. (2001) provide a chart for V1017 Sgr. The partially blended bright star immediately to the east of V1017 Sgr is CD −29◦15053. The living repository provided by Downes et al. (2001) is located at https://archive.stsci.edu/prepds/cvcat/, via Google, say. One then clicks on the Search field in A Catalog and Atlas of Cataclysmic Variables Archival Edition, types in the variable's GCVS Name, submits, clicks on GCVS Name, and the chart appears.

There is no AAVSO APASS photometry for V1017 Sgr in the UCAC4 catalog (Zacharias *et al.* 2013), most likely due to the blending of its image with that of CD –29º 15053.

The red star just to the east of V1017 Sgr, CD –29º 15053, lies at R. A. = $18^h\ 32^m\ 05.596^s$, and Dec. = –29º 23' 09.91", J2000. This star also has been catalogued as UCAC2 122-203212 and UCAC4 304-232904. The AAVSO APASS magnitude and color indices in UCAC4 for CD –29º 15053 are: $V = 10.147 \pm 0.010$; $B = 11.762 \pm 0.010$; hence, $(B–V) = +1.615 \pm 0.014$; $r = 9.524 \pm 0.010$, $i = 9.089 \pm 0.010$; hence, $(r–i) = +0.435 \pm 0.014$. There appears to be no spectral type in the literature for CD –29º 15053.

2. Observations

The dwarf nova V1017 Sgr has been observed on 41 nights at the Cerro Tololo Inter-American Observatory (CTIO) telescopes in the time interval between 1973 March 16 and 2001 October 7 ($2441757.8746 \leq JD \leq 2452189.56316$, for a span of 10,431 days or 28 years). Data were taken at the 0.4-m, (Lowell) 0.6-m, the 0.9-m, (Yale) 1.0-m, and 1.5-m CTIO telescopes. The 1973 and 1974 data have been published in Landolt (1975). The new data presented in this paper were obtained during 33 nights between 28 June 1975 and 7 October 2001. The data were taken through the filters described in Landolt (1975, 1983, 1992) in the order *VBUUBV* or *VBURIIRUBV*. An average 20 standard stars were observed each night. Extinction measurements were made and applied on a nightly basis.

Two problems may occur within some of these photoelectric data for V1017 Sgr and CD –29º 15053. The star field in which they are located is very crowded, and hence finding a spot for the sky readings was a challenge. The separation of V1017 Sgr and CD –29º 15053 is 1.14 seconds in right ascension and 2.46 arcseconds in declination, which leads to an angular separation of 15.2 arcseconds. This separation was on the order of the diaphragm sizes used (14 to 17 arcsec) at the different CTIO telescopes; hence each star's image had to be placed slightly off-center during its integration. Therefore, under some observing conditions, the closeness of the two stars together with the seeing, etc., had a possible effect on the measurements; see Figures 1 and 2. Since V1017 Sgr itself always is more than three magnitudes, some 20 times, fainter than its close neighbor, CD –29º 15053, the brighter star was little affected by its position in the photometer diaphragm. On the other hand, one had to be very careful in positioning V1017 Sgr in the diaphragm in such a way to minimize any possible effect of the nearby much brighter CD –29º 15053.

3. Discussion

The data acquisition information for 1973 and 1975 was discussed in Landolt (1975). The resulting *UBV* magnitudes and color indices for the 1975 and 1977 data were tied into the *UBV* photometric system as defined in Johnson *et al.* (1966). Data

Table 1. Photometric Errors per Night

UT (mmddyy)	JD (2400000.0+	Telescope	Filter	RMS Errors Recovered Standards					
				V	(B–V)	(U–B)	(V–R)	(R–I)	(V–I)
062875	42591.5	CTIO 1.0-m	UBV	0.027	0.022	0.017	—	—	—
062975	42592.5	CTIO 1.0-m	UBV	0.018	0.016	0.011	—	—	—
060977	43303.5	CTIO 0.6-m	UBV	0.015	0.006	0.016	—	—	—
061177	43305.5	CTIO 0.6-m	UBV	0.015	0.007	0.012	—	—	—
040978	43607.5	CTIO 0.4-m	UBVRI	0.013	0.009	0.022	0.008	0.010	0.009
041078	43608.5	CTIO 0.4-m	UBVRI	0.014	0.006	0.023	0.004	0.007	0.006
061278	43671.5	CTIO 0.6-m	UBVRI	0.010	0.007	0.010	0.004	0.004	0.005
110278	43814.5	CTIO 0.9-m	UBVRI	0.005	0.006	0.014	0.004	0.004	0.005
062479	44048.5	CTIO 0.9-m	UBVRI	0.009	0.010	0.018	0.005	0.006	0.006
062579	44049.5	CTIO 0.9-m	UBVRI	0.009	0.008	0.016	0.005	0.005	0.007
070880	44428.5	CTIO 0.9-m	UBV	0.008	0.012	0.010	—	—	—
091280	44494.5	CTIO 0.9-m	UBV	0.014	0.007	0.011	—	—	—
091680	44498.5	CTIO 0.9-m	UBVRI	0.010	0.011	0.023	0.007	0.006	0.008
061081	44765.5	CTIO 1.5-m	UBVRI	0.011	0.013	0.044	0.011	0.017	0.022
081081	44826.5	CTIO 0.4-m	UBV	0.010	0.009	0.011	—	—	—
102681	44903.5	CTIO 0.9-m	UBV	0.013	0.016	0.025	—	—	—
102881	44905.5	CTIO 0.9-m	UBVRI	0.014	0.009	0.023	0.007	0.004	0.007
091482	45226.5	CTIO 1.5-m	UBVRI	0.016	0.014	0.050	0.008	0.008	0.008
070583	45520.5	CTIO 1.5-m	UBVRI	0.006	0.007	0.006	0.003	0.004	0.004
092083	45597.5	CTIO 1.5-m	UBVRI	0.003	0.010	0.037	0.005	0.010	0.010
102183	45628.5	CTIO 0.9-m	UBVRI	0.005	0.007	0.012	0.002	0.004	0.005
051584	45835.5	CTIO 1.5-m	UBVRI	0.012	0.016	0.034	0.006	0.011	0.011
100584	45978.5	CTIO 0.9-m	UBVRI	0.010	0.006	0.015	0.008	0.005	0.007
101184	45984.5	CTIO 0.9-m	UBVRI	0.016	0.005	0.027	0.005	0.003	0.004
052486	46574.5	CTIO 1.5-m	UBVRI	0.008	0.008	0.066	0.006	0.017	0.017
102388	47457.5	CTIO 1.5-m	UBVRI	0.009	0.010	0.042	0.008	0.006	0.009
061390	48055.5	CTIO 1.5-m	UBVRI	0.006	0.009	0.023	0.005	0.006	0.010
061693	49154.5	CTIO 1.5-m	UBVRI	0.007	0.004	0.016	0.005	0.009	0.011
073195	49929.5	CTIO 1.5-m	UBVRI	0.004	0.008	0.020	—	—	—
082196	50316.5	CTIO 0.9-m	UBVRI	0.006	0.009	0.029	0.004	0.004	0.007
092598	51081.5	CTIO 1.5-m	UBVRI	0.008	0.009	0.032	0.007	0.011	0.014
100701	52189.5	CTIO 1.5-m	UBVRI	0.010	0.010	0.034	0.005	0.014	0.015
			ave.	0.011	0.010	0.023	0.006	0.008	0.009
			±	0.005	0.004	0.013	0.002	0.004	0.004

taken between and including 1975 through 1996 were tied into *UBVRI* standard stars as defined in Landolt (1983). The 1998 and 2001 data were tied into standard stars defined in Landolt (1992). The 1978 through 2001 data were reduced following precepts outlined in Landolt (2007).

The rms photometric errors calculated for each night were based on the recovered magnitudes and color indices of the standard stars. The relevant values are listed in Table 1. Columns one and two give the UT date of observation and the corresponding Julian Date, respectively. The telescope at which the data were obtained is given in the third column, and the filters through which the data were taken are in the fourth column. The last six columns provide the rms errors of the recovered standard stars' magnitude and colors for that night. The last two lines in Table 1 show that the average rms error of the recovered standard star photometry was one percent or less, except for (*U–B*).

The fifty-one final magnitudes and color indices for V1017 Sgr are listed in Table 2. Column one indicates the central Heliocentric Julian Day (HJD)for the time of observation. The remaining columns list the magnitude and color indices. This photometry is plotted in Figures 1 and 2. V1017 Sgr ranged in brightness between $12.822 \leq V \leq 13.996$ magnitudes, based on these 51 measures taken in the 1978–2001 time window. Its long term brightness in the *V* magnitude averaged 13.563 ± 0.217, based on all these data. This magnitude is close to the $V = 13.59 \pm 0.07$ reported by Webbink *et al.* (1987) from a reported 14 measures. This data set shows an overall fading by V1017 Sgr of 0.15 magnitude over the time interval covered by these data. Furthermore, the data show trends in the color indices: (*B–V*) is 0.015 magnitude more blue, (U–B) 0.029, (V–R) 0.038, (R–I) 0.030, and (V–I) 0.030 magnitude all more red. The significance in these correlations between the colors and Heliocentric Julian Days, however, is low; hence, one should be cognizant of probable over-interpretation.

As pointed out in Section 2, the scatter in the data points for V1017 Sgr may be due in part to the smaller telescopes used to collect the early data (see Table 1), together with the possible incursion of light from the nearby bright star CD –29º 15053. On the other hand, the latter star is known to be constant at the two percent level (see Table 3), and scatter in its *V* magnitude measures are a small fraction of the scatter seen in the V1017 Sgr *V* measures. Hence, the V1017 Sgr variations in brightness are in great part real.

No attempt has been made to identify or refine the orbital period of 5.714 days published by Sekiguchi (1992), as that problem is being addressed in a paper in preparation (Vargas-Salazar *et al.* 2016).

Table 2. UBVRI Photometry for V1017~Sgr.

HJD	V	(B–V)	(U–B)	(V–R)	(R–I)	(V–I)
2442591.82359	13.497	+1.070	+0.278	—	—	—
2442591.82571	13.459	+1.075	+0.289	—	—	—
2442592.82191	13.707	+0.966	–0.007	—	—	—
2442592.82380	13.724	+1.029	–0.080	—	—	—
2443303.90123	13.463	+1.112	+0.363	—	—	—
2443303.90295	13.381	+1.190	+0.250	—	—	—
2443303.90630	13.383	+1.104	+0.544	—	—	—
2443303.90800	13.536	+1.072	+0.169	—	—	—
2443305.89185	13.634	+1.203	+0.057	—	—	—
2443305.89369	13.608	+1.147	+0.295	—	—	—
2443305.89775	13.703	+1.059	+0.162	—	—	—
2443305.90038	13.722	+0.977	+0.190	—	—	—
2443607.87998	13.188	+1.195	+0.424	+0.638	+0.673	+1.311
2443607.90544	13.204	+1.244	+0.560	+0.660	+0.669	+1.330
2443608.90411	12.822	+1.530	+0.389	+0.475	+0.664	+1.137
2443671.90114	13.461	+1.240	+0.312	+0.695	+0.714	+1.409
2443814.51006	13.686	+0.864	+0.196	+0.724	+0.712	+1.434
2444048.71406	13.436	+1.026	+0.093	+0.695	+0.672	+1.368
2444048.72020	13.421	+1.091	+0.080	+0.663	+0.648	+1.312
2444049.69430	13.509	+1.083	–0.030	+0.702	+0.665	+1.367
2444049.70061	13.402	+1.061	+0.255	+0.702	+0.673	+1.374
2444428.72820	13.754	+1.107	+0.414	—	—	—
2444494.63202	13.597	+1.147	+0.382	—	—	—
2444494.63930	13.601	+1.138	+0.326	—	—	—
2444498.52823	13.467	+1.129	+0.189	+0.728	+0.660	+1.389
2444498.53068	13.421	+1.120	+0.374	+0.700	+0.662	+1.363
2444765.86779	13.674	+1.102	+0.346	+0.681	+0.642	+1.324
2444826.65622	13.052	+1.062	+0.611	—	—	—
2444826.65841	13.388	+1.186	+0.305	—	—	—
2444903.53862	13.530	+1.077	+0.256	—	—	—
2444905.55055	13.649	+1.118	+0.250	+0.708	+0.690	+1.400
2445226.51913	13.996	+1.068	+0.230	+0.721	+0.665	+1.387
2445520.77007	13.674	+1.101	+0.212	+0.676	+0.662	+1.338
2445597.58313	13.766	+1.129	+0.183	+0.709	+0.659	+1.368
2445628.55302	13.602	+1.161	+0.442	+0.653	+0.653	+1.306
2445835.81847	13.625	+1.075	+0.013	+0.683	+0.650	+1.334
2445835.82925	13.647	+0.985	+0.276	+0.689	+0.644	+1.334
2445835.83477	13.625	+1.042	+0.196	+0.685	+0.645	+1.331
2445835.84351	13.608	+1.086	+0.314	+0.659	+0.651	+1.311
2445978.58027	13.692	+1.287	+0.380	+0.645	+0.664	+1.310
2445984.54172	13.909	+1.145	+0.812	+0.747	+0.712	+1.460
2446574.84662	13.964	+1.230	+0.099	+0.800	+0.554	+1.350
2447457.56591	13.821	+1.195	+0.260	+0.722	+0.683	+1.398
2448055.81705	13.962	+1.156	+0.280	+0.692	+0.693	+1.383
2449154.87026	13.646	+0.963	+0.064	+0.675	+0.649	+1.329
2449929.49768	13.451	+1.046	+0.292	—	—	—
2449929.50437	13.402	+1.101	+0.275	—	—	—
2450316.51702	13.450	+1.111	+0.302	+0.699	+0.678	+1.378
2450316.52880	13.458	+1.090	+0.254	+0.715	+0.682	+1.398
2451081.53255	13.681	+1.106	+0.272	+0.688	+0.672	+1.360
2452189.56316	13.639	+1.113	+0.248	+0.691	+0.668	+1.354

The photometry which describes the nearby star, CD –29º 15053, is given in Table 3. This photometry is plotted in Figures 3 and 4. The average brightness and color indices for CD –29º 15053 are given in the last line of Table 3. As is evident in Table 3, on individual nights where multiple observations were obtained, the photometry repeated to well under one percent. However, even though the star appears to be constant in brightness and colors, the author thought it useful to publish the 29 individual measurements taken on 23 different nights, just in case the star does turn out to be variable. For instance, in their survey of G and K giants, Henry *et al.* (2000) have shown that "roughly one-fourth of their G giants, half of their K giants, and all of their M0 giants" are variable in light. The varibility of some giant stars also is described in Percy (2007). One cannot tell with assurance from the colors alone whether CD –29º 15053 is a dwarf or giant star, but from its location within UBVRI color-color plots, it most likely is a giant. The star is quite red in (U–B), in part due to the considerable reddening in the area. Given the small number statistics, is it sensible to look at the measures obtained and centered on UT 2443303.9, UT 2443305.89, UT 2445835.8, and UT 2450316.5 ($V = 10.193 \pm 0.007$, 10.194 ± 0.013, 10.191 ± 0.003, and 10.183 ± 0.004, respectively) and deduce a meaningful trend? The data do cover a time period of 21 years. Careful and properly standardized photometry would be useful.

Table 3. UBVRI Photometry for CD –29º 15053.

HJD	*V*	*(B–V)*	*(U–B)*	*(V–R)*	*(R–I)*	*(V–I)*
2442591.82771	10.162	+1.629	+1.707	—	—	—
2443303.89892	10.187	+1.620	+1.690	—	—	—
2443303.90483	10.201	+1.603	+1.702	—	—	—
2443303.90969	10.191	+1.616	+1.782	—	—	—
2443305.89020	10.185	+1.633	+1.767	—	—	—
2443305.89569	10.203	+1.603	+1.722	—	—	—
2443607.88530	10.232	+1.645	+1.774	+0.912	+0.817	+1.731
2443671.90418	10.161	+1.649	+1.636	+0.900	+0.806	+1.707
2443814.51336	10.151	+1.609	+1.704	+0.916	+0.812	+1.730
2444048.71723	10.198	+1.627	+1.768	+0.899	+0.815	+1.715
2444049.69744	10.190	+1.631	+1.793	+0.888	+0.820	+1.707
2444498.53315	10.185	+1.623	+1.809	+0.900	+0.817	+1.719
2444765.87296	10.165	+1.655	+1.850	+0.905	+0.811	+1.717
2444903.54074	10.174	+1.611	+1.777	—	—	—
2444905.55367	10.147	+1.645	+1.786	+0.909	+0.803	+1.714
2445226.52239	10.191	+1.640	+1.853	+0.903	+0.799	+1.704
2445520.77361	10.178	+1.650	+1.925	+0.900	+0.825	+1.727
2445597.58681	10.183	+1.663	+1.689	+0.906	+0.810	+1.717
2445628.55589	10.155	+1.636	+1.739	+0.899	+0.813	+1.713
2445835.82161	10.194	+1.636	+1.758	+0.888	+0.838	+1.727
2445835.83191	10.188	+1.654	+1.758	+0.906	+0.838	+1.746
2445835.83773	10.191	+1.648	+1.789	+0.896	+0.838	+1.736
2445978.58380	10.160	+1.642	+1.767	+0.905	+0.811	+1.718
2447457.57190	10.187	+1.630	+1.781	+0.918	+0.808	+1.713
2448055.81358	10.224	+1.666	+1.910	+0.906	+0.831	+1.737
2449154.87540	10.163	+1.612	+1.795	+0.909	+0.804	+1.718
2449929.50111	10.183	+1.622	+1.739	—	—	—
2450316.52187	10.186	+1.639	+1.732	+0.904	+0.819	+1.724
2450316.53359	10.180	+1.641	+1.729	+0.898	+0.823	+1.722
ave.	10.183	+1.634	+1.767	+0.903	+0.817	+1.721
±	0.020	0.017	0.063	0.008	0.012	0.011

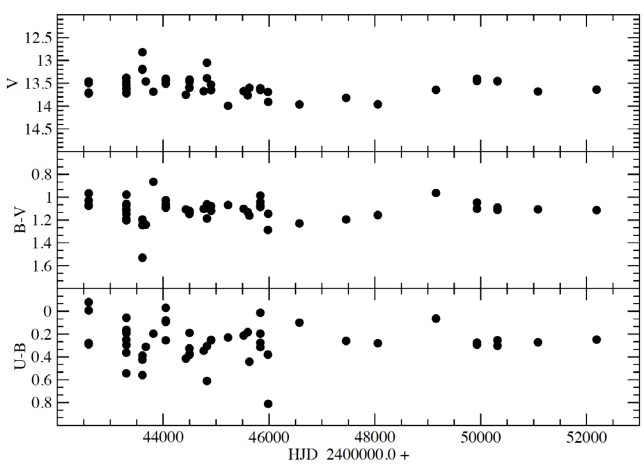

Figure 1. *V* magnitude and (*B–V*) and (*U–B*) color index light curves for V1017 Sgr.

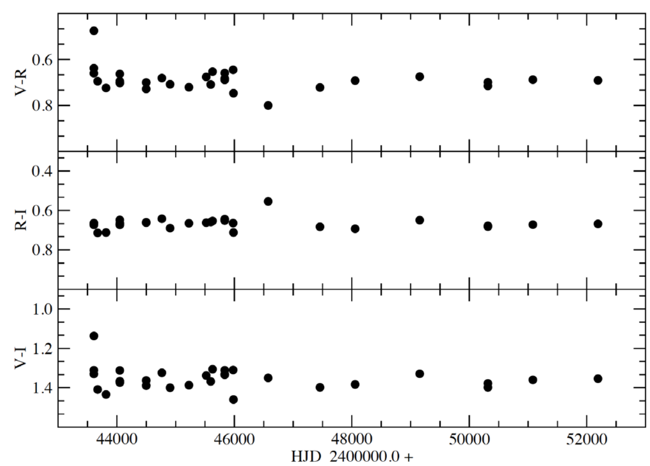

Figure 2. (*V–R*), (*R–I*), and (*V–I*) color index light curves for V1017 Sgr.

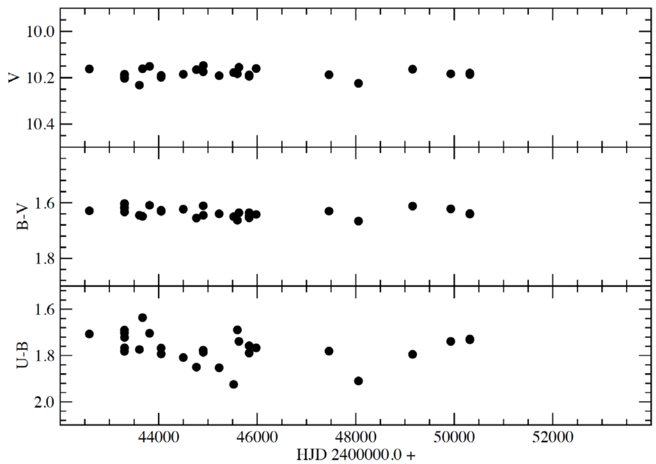

Figure 3. *V* magnitude and (*B–V*) and (*U–B*) color index light curves for the nearby star CD –29º 15053.

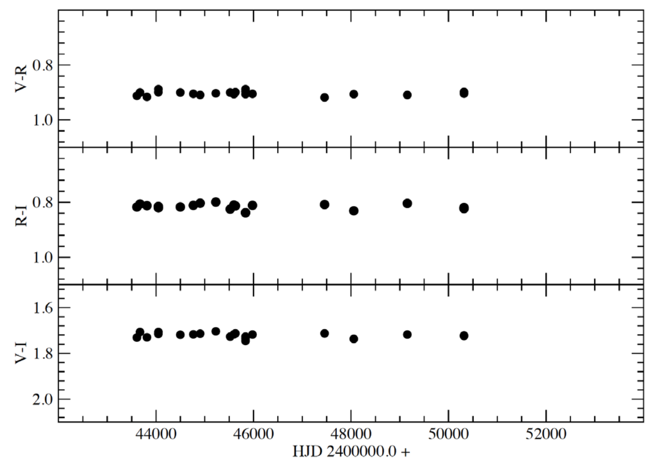

Figure 4. (*V–R*), (*R–I*), and (*V–I*) color index light curves for the nearby star CD –29º 15053.

4. Summary

In summary, very detailed information and summaries regarding the known characteristics of V1017 Sgr may be found in Webbink *et al.* (1987), Sekiguchi (1992), many locations in Warner (1995), Schaefer (2010), and in Pagnotta and Schaefer (2014). The new data herein should be useful in a more indepth study of V1017 Sgr as in Vargas-Salazar *et al.* (in preparation 2016).

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