The Dwarf Nova SY Cancri and its Environs

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Abstract Multicolor UBVRI photometry, collected intermittedly over a period of 22 years, is presented for the dwarf nova SY Cancri. Additional UBVRI photometry for a handful of sequence stars in the vicinity of SY Cancri is also presented.

1. Introduction

The dwarf nova SY Cancri (R. A. = 09^h 01^m 03.23^s, Dec. = +17° 53' 56.2"; J2000) was discovered to be variable by Mme. L. Ceraski as announced by S. Blažko (1929). She observed a light variation between photographic magnitude 9.5 and 12.5, based on 14 photographic plates taken in the time frame 1912–1928. The star initially designated as AN 401.1929 also is known as BD+18° 2101, GSC 01397-00817, 2MASS J09010332+1753561, PG 0858+181, SV 228, AAVSO AUID 000-BBQ-187, and UCAC4 540-048343.

Selected references for SY Cnc and its variable star cousins are illustrative for readers new to this kind of variable star. The characteristics of cataclysmic variable stars (CVs), a sub-group within the CVs called dwarf novae, and a further sub-division within the dwarf novae sub-group called Z Cam stars, is described extensively in Warner (1995). Sterken and Jaschek (1996) illustrate characteristic light curves for these variable stars, essentially all interacting binary systems. Dwarf novae brightnesses may increase by as much as six magnitudes (Percy 2007). The Z Cam variable star sub-group features frequent outbursts (Warner 1995), and "have a defining characteristic of a 'still stand' or halt [in the decline of] their light curve on the way down from maximum [brightness] (Percy 2007)." Words added by the authors are indicated within square brackets. A recent summary of the Z Cam subset was given by Simonsen (2011) and by Simonsen *et al.* (2014), wherein SY Cnc was included as a bona fide Z Cam class variable star.

Additional information useful in understanding these variable stars may be found in the following papers. Kraft and Luyten (1965) derived the mean absolute magnitudes of dwarf novae at minimum light to be $M_V = +7.5 \pm 0.7$, based on proper motions and radial velocities. Early AAVSO observations for this class variable star, including SY Cnc, were reported by Mayall (1968) and by Mattei (1974). An initial review of the structure of cataclysmic variables was written by Robinson (1976). A discussion of a variety of observational characteristics for dwarf novae, including SY Cnc, and taken from the AAVSO archives, appeared in Szkody and Mattei (1984). BVRI photometry was published by Spogli (1993). Secondary standards in the field of SY Cnc were provided by Henden and Honeycutt (1997). Bruch and Engel (1994) reported a color excess for SY Cnc of $E_{(B-V)} = 0.0$.

Shafter *et al.* (2005) determined, from AAVSO data, a recurrence time versus orbital period relation for variable stars of the Z Cam type. SY Cnc has the longest orbital period, at 0.380 day, in the group that they considered. Smith *et al.* (2005) conclude that the secondary companion in the SY Cnc binary system is a non-main-sequence star which fills its Roche lobe.

2. Observations

Data were obtained for SY Cnc intermittently in the time frame 1984 November through 2005 April, a period of 22 years, as primary observing programs permitted. Consequently, a variety of telescopes, detectors, and filter sets was employed for the data acquisition. A listing of telescopes, detectors, and filter sets is given in Table 1. The first column lists the UT date during which data were taken. The observatory site and telescope utilized are given next. The KPNO 0.9-m telescope used on 1993 March 16 UT, which is the 0.9-m currently on site, resulted from a combination of the two original 0.9-m telescopes on Kitt Peak, namely the No.1 0.9-m and No.2 0.9-m. The third column indicates that photomultipliers were the detector of choice except for the night of 2002 March 12 UT. Normally a 14-arc second diaphragm was used for the photoelectric observations. A description of the different filter sets used in the data acquisition process is presented in the last column. The identification includes the filter and the filter's identification number in the KPNO and CTIO filter databases. The UBVRI set of filters used at the Lowell Perkins 1.8-m telescope was the KPNO J filter set of UBVRI filters.

The majority of the data herein was taken as part of AUL's standard star programs. An overview of data acquisition procedures and reduction techniques may be found in Landolt

Table 1. Telescopes, Detectors, and Filters.

UT mmddyy	*Observatory Telescope*	*Detector Set-up*	*Filter Identifications*
111284	KPNO #1 0.9-m	1P21; cold box 10	V, 232; B, 233; U, 974 + solid CuSO4
111484	KPNO #1 0.9-m	1P21; cold box 10	V, 232; B, 233; U, 974 + solid CuSO4
121885	KPNO #2 0.9-m	1P21; cold box 10	V, 232; B, 233; U, 974 + solid CuSO4
121985	KPNO #2 0.9-m	1P21; cold box 10	V, 232; B, 233; U, 974 + solid CuSO4
111588	KPNO 1.3-m	RCA 31034A-02; coldbox 51	J filter set: I, 1114; R, 1113; V, 1112; B, 1111; U-234+CuSO4
011790	KPNO #2 0.9-m	1P21; cold box 10	V, 232; B, 233; U, 974 + solid CuSO4
032490	KPNO 1.3-m	RCA 31034A-02; cold box 51	J filter set: I, 1114; R, 1113; V, 1112; B, 1111; U-234+CuSO4
031693	KPNO 0.9-m	RCA 31034A-02; cold box 51	J filter set: I, 1114; R, 1113; V, 1112; B, 1111; U-234+CuSO4
030996	CTIO 1.0-m	RCA 31034A-02; cold box 60	Landolt (1983), Table III
031896	CTIO 1.5-m	RCA 31034A-02; cold box 60	Landolt (1983), Table III
031202	CTIO 1.5-m	CCD, Tek 2K #3	CCD Tek set #3
041205	Lowell 1.8-m	RCA 31034A-02	J filter set: I, 1114; R, 1113; V, 1112; B, 1111; U-234+CuSO4

(2007). Since the data were acquired over a twenty-two year period, several different combinations of detectors, coldboxes, mountain tops, and filter sets were involved. The UBVRI photometry taken under differing circumstances was standardized through use of different editions of standard stars (Landolt 1983, 1992). There were too few data in common between the ten observing runs to tie the final magnitudes and color indices together as tightly as could be done, say in the definition of standard star lists, e.g., Landolt (1992, 2009). The resulting photometric errors for a given star therefore are somewhat larger than one might like. An indication of the errors for the measured photoelectric-based magnitudes and color indices is listed in Table 2. The errors in Table 2 are the average errors of a single observation for the recovered magnitudes and color indices of the standard stars used to calibrate the nightly photometry into the UBVRI photometric system as defined by Landolt (1983, 1992). Since, on occasion, SY Cnc was somewhat fainter than the standard stars, those fainter observations' errors may be a percent or two larger.

Table 2. RMS Photometric Errors per Night.

UT mmddyy	*HJD 2400000.0+*	*V*	*RMS Errors Recovered Standards (B–V)*	*(U–B)*	*(V–R)*	*(R–I)*	*(V–I)*
111284	46016.5	0.009	0.006	0.023	—	—	—
111484	46018.5	0.005	0.006	0.017	—	—	—
121885	46417.5	0.007	0.009	0.012	—	—	—
121985	46418.5	0.010	0.004	0.015	—	—	—
111588	47480.5	0.010	0.005	0.009	0.004	0.004	0.004
011790	47908.5	0.009	0.010	0.023	—	—	—
032490	47974.5	0.013	0.008	0.016	0.006	0.004	0.008
031693	49062.5	0.007	0.006	0.013	0.004	0.006	0.005
030996	50151.5	0.009	0.012	0.024	—	—	—
031896	50160.5	0.008	0.011	0.023	0.006	0.004	0.007
031202	52345.5	—	—	—	—	—	—
041205	53472.5	0.007	0.005	0.020	0.011	0.015	0.021
	ave	0.009	0.007	0.018	0.006	0.007	0.009
	±	0.002	0.003	0.005	0.003	0.005	0.007

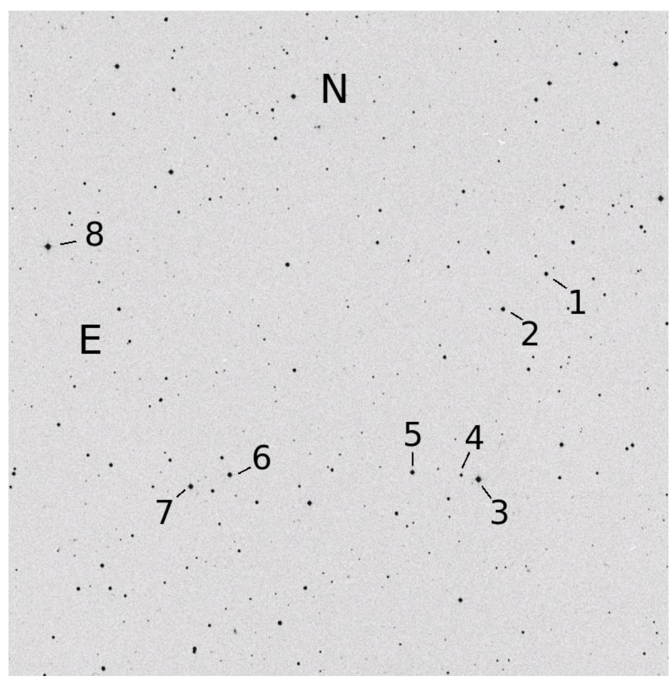

Figure 1. Finding chart for photoelectric measurements of SY Cnc and sequence stars (Tables 4 and 5). SY Cnc is star 3. The field of view is approximately 30 arc minutes on a side.

3. Discussion

Two finding charts, each with a separate purpose, are provided. SY Cnc and photoelectrically observed sequence stars in its vicinity, similar to standard AAVSO charts, are identified in Figure 1. The numerous stars with CCD measurements preclude identifying each star. Identifications for several brighter stars observed with the CCD detector are shown in Figure 2. The accuracy of the coordinates in Table 3 enable the identification in Figure 2 of the remaining stars observed with the CCD. When the photoelectric observational program was begun in 1984 November, the finding chart employed was an AAVSO chart dated 17 December 1968 (revised). The selection of sequence stars that was observed photoelectrically at the telescope was based on the identification numbers on that chart. Those numbers actually were the then-adopted brightness of each AAVSO sequence star. Consequently, our identification numbers for the photoelectrically-observed stars in the SY Cnc field, presented in column one of Table 4, are cross-identified with the identification numbers from the 1968 AAVSO chart in column two. The UCAC4 catalogue identification, Zacharias *et al.* (2013), is in the third column, and that catalogue's right ascension and declination for J2000 are presented in the last

Table 3. CCD Photometry of Nearby Stars.

Ident.	*UCAC4*	*R.A.(J2000.0)*	*Dec.(J2000.0)*	V	(B–V)	(U–B)	(V–R)	(R–I)	(V–I)	V	(B–V)	(U–B)	(V–R)	(R–I)	(V–I)
		h m s	*° ′ ″*							*Observation Errors*					
1	540–048331	09 00 34.31	17 55 32.9	13.414	0.715	0.328	0.377	0.404	0.781	0.0069	0.0075	0.0047	0.0072	0.0025	0.0071
2	540–048332	09 00 35.00	17 55 19.9	13.716	1.052	0.905	0.605	0.649	1.254	0.0082	0.0096	0.0156	0.0096	0.0056	0.0086
3	540–048333	09 00 40.62	17 57 48.1	15.168	0.724	0.355	0.387	0.404	0.791	0.0046	0.0076	0.0099	0.0057	0.0086	0.0091
4	540–048334	09 00 40.92	17 54 17.3	15.333	0.766	0.299	0.408	0.433	0.841	0.0040	0.0076	0.0102	0.0079	0.0079	0.0057
5	—	09 00 41.66	17 51 00.9	18.217	0.667	0.209	0.451	0.482	0.933	0.0311	0.0880	0.1057	0.0437	0.0507	0.0509
6	541–047626	09 00 42.45	18 00 23.4	16.775	0.920	0.755	0.472	0.563	1.035	0.0097	0.0475	0.0594	0.0175	0.0175	0.0137
7	—	09 00 44.11	17 56 07.3	18.522	0.408	–0.036	0.417	0.370	0.787	0.0454	0.0672	0.0762	0.0580	0.0628	0.0686
8	—	09 00 45.57	17 53 10.6	18.816	0.524	–0.273	0.278	0.175	0.453	0.0540	0.0916	0.2125	0.0914	0.1787	0.1715
9	540–048335	09 00 46.51	17 59 29.1	16.078	1.266	1.264	0.714	0.753	1.467	0.0060	0.0169	0.1044	0.0107	0.0103	0.0080
10	540–048336	09 00 47.55	17 58 55.7	15.851	1.324	1.171	0.948	1.304	2.252	0.0113	0.1255	0.1289	0.0136	0.0079	0.0116
11	540–048337	09 00 47.65	17 55 32.1	12.612	0.903	0.667	0.494	0.494	0.988	0.0015	0.0039	0.0046	0.0021	0.0020	0.0021
12	540–048338	09 00 47.96	17 54 01.8	14.545	0.399	–0.196	0.246	0.321	0.567	0.0056	0.0067	0.0052	0.0062	0.0043	0.0065
13	540–048339	09 00 48.35	17 57 56.7	15.850	0.627	0.018	0.342	0.398	0.740	0.0058	0.0152	0.0297	0.0079	0.0083	0.0086
14	540–048341	09 00 53.30	17 59 28.0	15.541	0.760	0.385	0.396	0.413	0.809	0.0100	0.0139	0.0134	0.0108	0.0073	0.0117
15	540–048342	09 00 54.17	17 58 54.9	14.072	0.630	0.165	0.347	0.364	0.711	0.0030	0.0051	0.0054	0.0039	0.0042	0.0045
16	—	09 00 54.21	17 50 02.4	17.013	0.680	0.131	0.445	0.318	0.763	0.0116	0.0239	0.0312	0.0857	0.0880	0.0260
17	539–047119	09 00 54.56	17 47 04.2	14.486	1.005	1.221	0.560	0.546	1.106	0.0028	0.0087	0.0131	0.0037	0.0050	0.0052
18	—	09 00 58.11	17 49 59.2	17.100	0.638	0.118	0.363	0.361	0.724	0.0125	0.0228	0.0307	0.0171	0.0415	0.0417
19	—	09 00 59.02	17 55 57.9	17.575	0.433	–0.259	0.275	0.394	0.669	0.0183	0.0297	0.0320	0.0265	0.0314	0.0308
20	541–047637	09 00 59.14	18 01 36.4	12.450	0.963	0.851	0.499	0.537	1.036	0.0037	0.0044	0.0038	0.0039	0.0049	0.0060
21	—	09 00 59.79	17 49 57.2	17.237	0.642	0.103	0.364	0.399	0.763	0.0138	0.0266	0.0345	0.0191	0.0217	0.0221
22	—	09 01 01.64	18 01 37.4	16.961	1.026	1.014	0.558	0.542	1.100	0.0124	0.0615	0.1240	0.0157	0.0144	0.0164
23	540–048343	09 01 03.32	17 53 56.1	13.621	0.528	–0.474	0.380	0.474	0.854	0.0048	0.0073	0.0111	0.0053	0.0029	0.0051
24	540–048344	09 01 06.67	17 48 28.3	12.680	0.828	0.556	0.446	0.439	0.885	0.0037	0.0045	0.0042	0.0041	0.0024	0.0041
25	540–048345	09 01 06.70	17 54 07.1	14.238	0.642	0.154	0.345	0.373	0.718	0.0037	0.0077	0.0081	0.0044	0.0035	0.0045
26	—	09 01 06.91	17 51 07.3	17.896	0.664	–0.116	0.344	0.441	0.785	0.0248	0.0724	0.0801	0.0412	0.0497	0.0448
27	540–048346	09 01 07.87	17 55 44.0	16.897	1.229	1.033	0.673	0.648	1.321	0.0211	0.0418	0.0747	0.0233	0.0143	0.0235
28	540–048347	09 01 08.81	17 52 13.8	16.727	0.784	0.270	0.417	0.416	0.833	0.0094	0.0342	0.0421	0.0158	0.0173	0.0150
29	540–048348	09 01 09.07	17 53 02.9	14.996	0.637	0.071	0.355	0.404	0.759	0.0056	0.0076	0.0079	0.0066	0.0048	0.0066
30	540–048349	09 01 10.06	17 59 24.9	13.575	0.821	0.434	0.440	0.465	0.905	0.0021	0.0048	0.0060	0.0031	0.0058	0.0057
31	540–048350	09 01 11.00	17 59 57.3	16.924	0.755	0.292	0.400	0.455	0.855	0.0152	0.0327	0.0396	0.0180	0.0200	0.0232
32	540–048351	09 01 11.09	17 54 22.3	16.905	0.599	–0.024	0.321	0.373	0.694	0.0108	0.0459	0.0483	0.0161	0.0265	0.0260
33	540–048352	09 01 12.53	17 50 35.8	16.542	1.240	1.162	0.711	0.691	1.402	0.0120	0.0247	0.0566	0.0140	0.0131	0.0162
34	540–048353	09 01 15.72	17 51 55.8	16.434	1.056	0.743	0.593	0.581	1.174	0.0092	0.0214	0.0368	0.0112	0.0097	0.0117
35	540–048354	09 01 15.89	17 54 12.1	12.821	0.213	0.035	0.104	0.142	0.246	0.0037	0.0061	0.0054	0.0041	0.0025	0.0041
36	540–048355	09 01 16.86	17 51 44.9	15.236	1.358	0.983	0.796	0.836	1.632	0.0048	0.0160	0.0230	0.0056	0.0040	0.0056
37	540–048356	09 01 18.77	17 52 20.8	14.005	0.571	–0.022	0.323	0.372	0.695	0.0023	0.0041	0.0069	0.0072	0.0071	0.0032
38	—	09 01 18.99	17 58 37.7	17.690	0.910	0.218	0.444	0.523	0.967	0.0192	0.0450	0.0685	0.0257	0.0279	0.0292
39	540–048357	09 01 20.33	17 49 30.0	16.041	0.502	–0.055	0.308	0.356	0.664	0.0060	0.0102	0.0133	0.0086	0.0105	0.0104
40	540–048358	09 01 21.62	17 57 43.3	16.969	1.418	1.094	1.033	1.363	2.396	0.0108	0.0378	0.1517	0.0131	0.0107	0.0133
41	540–048360	09 01 23.63	17 58 29.0	15.795	1.186	1.140	0.661	0.649	1.310	0.0106	0.0236	0.0366	0.0119	0.0074	0.0117
42	—	09 01 24.90	17 52 40.7	17.982	0.871	0.597	0.411	0.515	0.926	0.0499	0.0735	0.1043	0.0552	0.0449	0.0629
43	540–048361	09 01 25.63	17 55 58.3	16.280	1.452	1.232	0.886	0.919	1.805	0.0067	0.0214	0.0583	0.0387	0.0384	0.0080
44	—	09 01 27.23	17 50 41.8	18.479	0.801	0.192	0.373	0.324	0.697	0.0491	0.1453	0.2365	0.0599	0.1096	0.1151
45	540–048362	09 01 29.75	17 54 58.4	16.555	0.892	0.551	0.497	0.529	1.026	0.0098	0.0381	0.0481	0.0150	0.0150	0.0139
46	540–048363	09 01 30.90	17 49 14.2	16.768	0.624	–0.086	0.402	0.458	0.860	0.0219	0.0314	0.0275	0.0244	0.0236	0.0303
47	540–048364	09 01 31.16	17 54 16.5	14.662	0.533	0.145	0.321	0.372	0.693	0.0082	0.0718	0.0715	0.0086	0.0043	0.0089
48	540–048365	09 01 31.92	17 54 23.8	16.717	0.803	0.477	0.432	0.446	0.878	0.0093	0.0280	0.0388	0.0123	0.0130	0.0138
49	—	09 01 32.59	17 49 36.7	17.081	1.028	1.020	0.552	0.577	1.129	0.0464	0.0808	0.0912	0.0479	0.0389	0.0593

two columns. The UBVRI photoelectric photometry for these comparison stars appears in Table 5.

Observations were downloaded from the AAVSO photometric database in the Julian Day (JD) time interval 2445700.5 ≤ JD ≤ 2453736.5 to encompass the time frame for the new data described in this paper. These AAVSO data between 1984 January 1 and 2006 January 1 UT cover 8,036 days, or 22.0 years. Visual observations indicating "fainter than" and those taken through filters other than "Johnson *V*" then were eliminated from the listing. The remaining 13,349 AAVSO observations have been displayed in Figure 3 as black filled circles.

The new photoelectric data herein for SY Cnc, tabulated in Table 6, are illustrated in Figures 3, 4, and 5. The photoelectric *V*-magnitude data have been overlaid, as red filled circles, onto the AAVSO database points in Figure 3. Figures 4 and 5 illustrate the photoelectric data as a function of Heliocentric Julian Day (HJD) (one is reminded that the AAVSO database observations are in Julian Days (JDs), whereas the authors' are in Heliocentric Julian Days (HJDs)). While appearing somewhat redundant, the presentation of the *V* photoelectric data again in Figure 4 shows the behavior of those data free of the clutter of Figure 3, as well as permitting a more clear picture of the behavior of the *V* photoelectric data concurrent with the photoelectric color data plotted in Figure 5.

These data show a range in brightness of $11.21 \leq V \leq 13.62$ and in color index of $-0.02 \leq (B-V) \leq +0.53$. The times of observation found SY Cnc either near its brightest, $V \sim 11$, or its faintest, $V \sim 13$ magnitude. The average of seven observations near its brightest found $(U–B) = –0.80 \pm 0.04$ and $(B–V) = +0.04 \pm 0.04$. The average of ten observations near SY Cnc's faintest found $(U–B) = –0.72 \pm 0.11$, and $(B–V) = +0.40 \pm 0.07$. There appears to be a trend, following HJD 2452000 and shown in Figure 5, in all color indices, except perhaps $(U–B)$, by more than a couple tenths of a magnitude toward redder colors.

CCD observations of the SY Cnc field in Table 3 were obtained on the photometric night of 2002 March 12 UT at the CTIO 1.5-m telescope. The detector was CTIO's Tek2k No.6, and the filter set was CTIO's Tek No.3, all 3 × 3 inch filters. A 14-arc second equivalent aperture was used in the reduction of the CCD data (Clem and Landolt) 2013, thereby ensuring that both the standard and program stars were reduced with the same aperture size as was employed in the definition of the standard stars. These data were calibrated with standards defined in Landolt (1992). Similar observation and reduction procedures have been described in Clem and Landolt (2013). Two successive frames were taken of the SY Cnc field, with exposures of 180, 30, 20, 20, and 30 seconds through the *U, B, V, R,* and *I* filters, respectively.

A running number for the CCD data for these 49 stars is given in the first column of Table 3. The corresponding identification in the second column, together with the coordinates in columns three and four, are from the UCAC4 catalogue (Zacharias *et al.* 2013). In instances where UCAC4 identifications did not exist, coordinates were derived from this CCD image material [see Clem and Landolt (2013), section 3.3 for details]. The *UBVRI* photometry based on the CCD data is given in columns five through ten. Since the CCD photometry came from two exposures on one telescope setting on one night, the errors indicated are a combination of instrumental errors combined with errors resulting from the calibration of the instrumental photometry to the standard system. These errors are labeled as observation errors for each star's data as presented in columns eleven through sixteen. The single CCD-based photometric data point for SY Cnc from Table 3 falls at HJD 2452345.60401 in Figures 3, 4, and 5.

The errors in the CCD *V* magnitudes in Table 3 as a function of the CCD *V* magnitude are illustrated in Figure 6. They are on the order of ≤ 0.01 magnitude for stars brighter than $V = 16.5$, and less than two percent down to $V \sim 16.8$. Figure 7, using data in Table 3, shows the scale to be linear when intercomparing the APASS *V* magnitude with our CCD *V* magnitude. The difference APASS *V* magnitudes minus the CCD *V* magnitudes in Table 3

Table 4. Comparsion Stars for SY Cnc.

Ident.	*Old Ident.*	*UCAC4*	*R. A. (J2000.0)* h m s	*Dec. (J2000.0)* ° ′ ″
1	var	541-047633	09 00 50.936	+18 03 12.58
2	124	541-047637	09 00 59.139	+18 01 36.32
3	SY	540-048343	09 01 03.314	+17 53 56.03
4	142	540-048345	09 01 06.693	+17 54 07.07
5	130	540-048354	09 01 15.888	+17 54 12.14
6	122	540-048376	09 01 50.541	+17 53 59.07
7	126	540-048382	09 01 57.892	+17 53 27.85
8	115	541-047674	09 02 25.595	+18 04 09.39

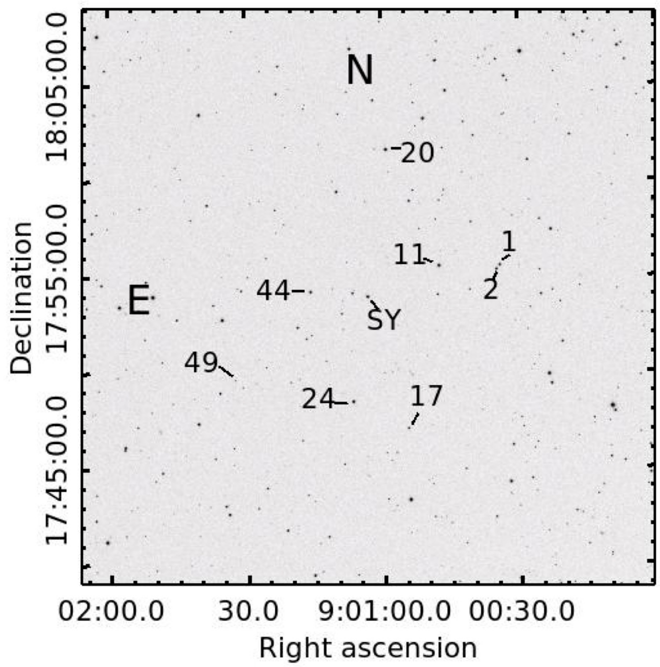

Figure 2. Finding chart for SY Cnc and CCD measured sequence stars from Table 3. The field of view is approximately 25 arc minutes on a side.

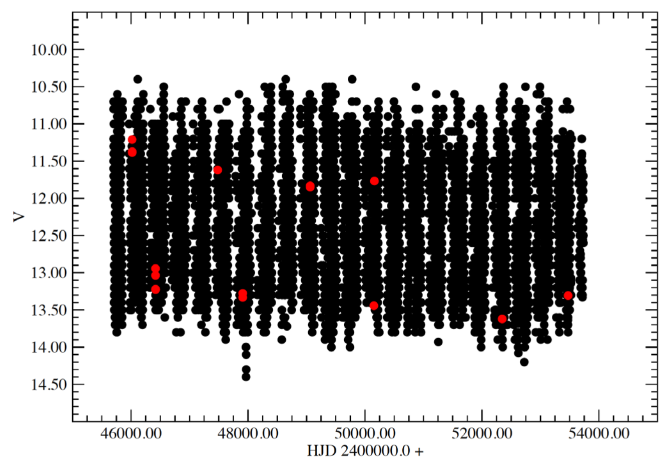

Figure 3. Visual AAVSO database V magnitudes plus V photoelectric and CCD magnitudes from this paper for SY €nc. Black color coding indicates AAVSO data; red color coding illustrates photoelectric data from Table 6 and CCD data from Table 3.

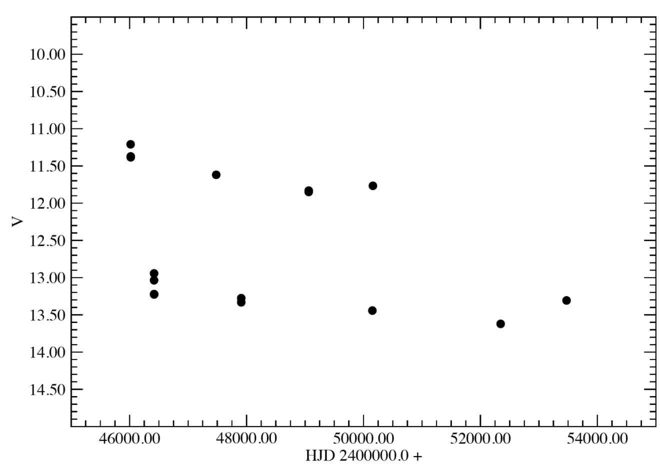

Figure 4. Photoelectric *V* magnitudes for SY Cnc from Table 6 as a function of HJD.

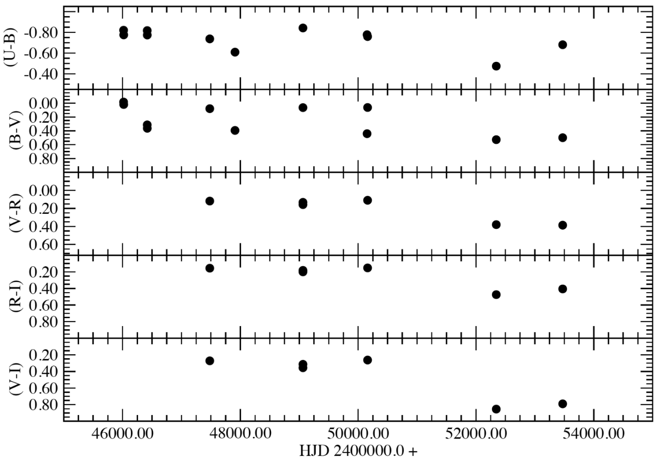

Figure 5. Photoelectric *UBVRI* color indices for SY Cnc from Table 6 as a function of HJD.

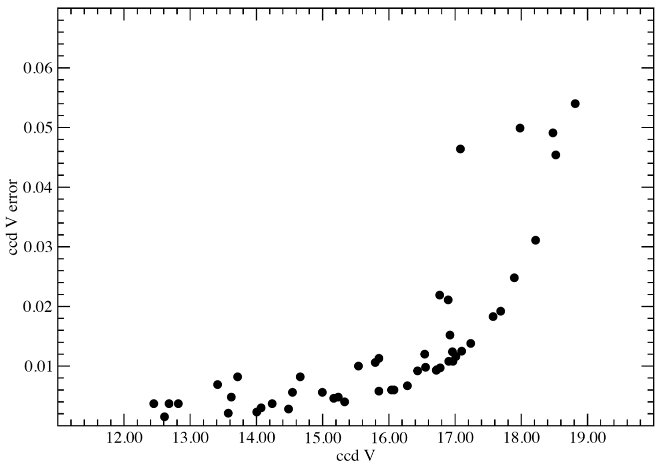

Figure 6. CCD *V* magnitude errors as a function of the CCD *V* magnitude from Table 3.

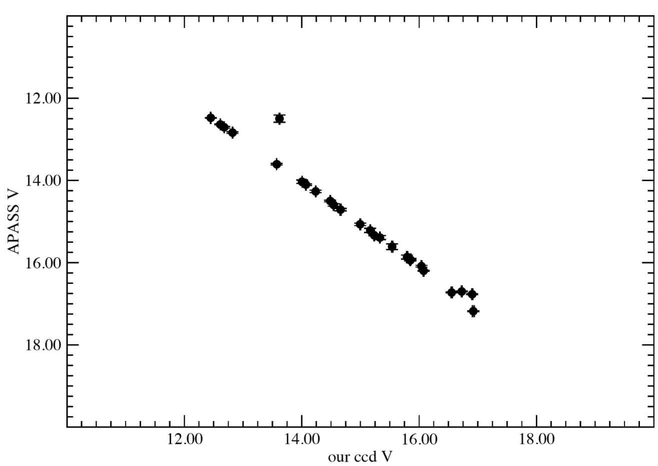

Figure 7. The APASS *V* magnitude plotted against the CCD *V* magnitude in Table 3. The outlier is SY Cnc.

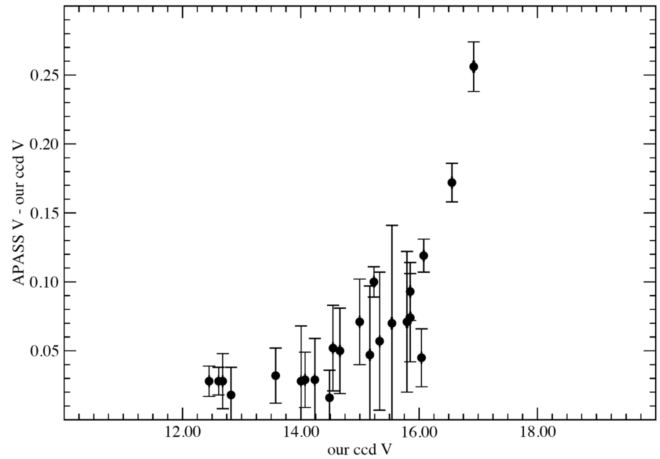

Figure 8. The difference between APASS *V* magnitude and the CCD *V* magnitudes in Table 3 versus the CCD *V* magnitudes in Table 3.

is +0.054 ± 0.069, for the 25 stars for which there are UCAC4 data. Consideration of stars brighter than $V = 15$th magnitude gives a difference of +0.034 ± 0.016. The outlier star in Figure 7 is SY Cnc, which has been excluded from these comparisons.

Figure 8 compares, for stars in the vicinity of SY Cnc, the difference between the UCAC4 *V* magnitudes, taken from APASS, and the CCD *V* magnitudes, with the CCD *V* magnitudes from Table 3. A divergence beginning about $V =$ 15th magnitude becomes much stronger for stars fainter than $V = 16.2$, near the effective faint limit for both data sets.

It would be of interest to determine whether SY Cnc, as an object, shows any long term overall light variation. An examination of Figure 3 by eye is not sufficient. Consequently, the AAVSO data that were plotted in Figure 3 were subdivided by year. Each year's data provided an average magnitude and associated error. The associated mid-year Julian Day was taken to be 30 June. This resulted in a table of 22 mid-year Julian Days and associated average *V* magnitudes and associated errors. A linear regression was performed on these twenty-two pairs of Julian Date and magnitude, providing a relation:

$$\overline{V} = 12.72 \pm 0.56 - 6.142 \times 10^{-6} \pm 1.130 \times 10^{-5} \text{ JD}. \qquad (1)$$

Application of this relation to an interval of 10,000 days, 2445000 < JD < 2455000 encompassing the data herein, indicates an overall increase in brightness of 0.06 magnitude. While there does appear to be a slight brightening, the size of the errors associated with the coefficients indicates low significance.

Table 4 contains GSC 01397-00509, also known as UCAC4 541-047633, a star in the field of SY Cnc. The star has a moderate proper motion of $\mu_\alpha = -40.8 \pm 2.7$ mas yr^{-1} and $\mu_\delta = -21.0 \pm 1.5$ mas yr^{-1}. Its APASS magnitude and color index are $V = 12.730$ and $(B-V) = +0.829$. When AUL initially began observations of SY Cnc and stars in its vicinity, GSC 01397-00509 was marked "var." on the AAVSO chart dated 17 December 1968 (revised), a possible variable star. Cook (1984) noted that the sequence for SY Cnc of that era was not in good shape. Hence, several random observations of this star also were obtained over the next years, and are presented in Table 7. While one might expect smaller errors for a star of GSC 01397-00509's brightness and

Table 5. Comparison Stars' UBVRI Photoelectric Data.

Ident.	V	(B–V)	(U–B)	(V–R)	(R–I)	(V–I)	*n*	V	(B–V)	(U–B)	(V–R)	(R–I)	(V–I)
										RMS Errors			
SY 115	10.813	+0.556	+0.015	+0.343	+0.340	+0.680	7	0.018	0.019	0.017	0.000	0.002	0.001
SY 122	11.704	+0.995	+0.766	+0.538	+0.508	+1.044	8	0.011	0.010	0.021	0.004	0.007	0.003
SY 124	12.491	+0.989	+0.762	—	—	—	1	—	—	—	—	—	—
SY 126	12.035	+0.499	-0.015	+0.306	+0.297	+0.602	8	0.006	0.012	0.019	0.001	0.003	—
SY 130	12.841	+0.204	+0.055	+0.104	+0.142	+0.246	3	0.017	0.009	0.081	—	—	—
SY 142	14.283	+0.604	+0.199	+0.345	+0.373	+0.718	3	0.043	0.033	0.041	—	—	—

Table 6. UBVRI Photoelectric Data for SY Cnc.

UT mmddyy	*HJD 2400000.0+*	*V m*	*(B–V) m*	*(U–B) m*	*(V–R) m*	*(R–I) m*	*(V–I) m*
111284	46017.03000	11.210	–0.017	–0.820	—	—	—
111484	46018.98586	11.384	+0.019	–0.775	—	—	—
111484	46019.00338	11.372	+0.016	–0.794	—	—	—
121885	46418.03016	13.036	+0.313	–0.817	—	—	—
121885	46418.04486	12.944	+0.345	–0.778	—	—	—
121985	46418.98997	13.221	+0.363	–0.774	—	—	—
121985	46419.00078	13.224	+0.325	–0.814	—	—	—
121985	46419.00878	13.226	+0.363	–0.792	—	—	—
111588	47480.98158	11.619	+0.079	–0.737	+0.119	+0.156	+0.272
011790	47908.93623	13.276	+0.394	–0.609	—	—	—
011790	47908.95925	13.332	+0.418	–0.635	—	—	—
031693	49062.66303	11.849	+0.064	–0.842	+0.133	+0.182	+0.314
031693	49062.66567	11.831	+0.075	–0.846	+0.158	+0.200	+0.356
030996	50151.60221	13.443	+0.441	–0.777	—	—	—
031896	50160.55609	11.767	+0.062	–0.759	+0.110	+0.152	+0.263
031202	52345.60401	13.621	+0.528	–0.474	+0.380	+0.474	+0.854
041205	53472.70440	13.307	+0.499	-0.680	+0.386	+0.406	+0.791

Table 7. Multi-color Photometry for GSC 01397-00509.

UT mmddyy	*HJD 2400000.0+*	*V m*	*(B–V) m*	*(U–B) m*	*(V–R) m*	*(R–I) m*	*(V–I) m*
121885	46418.03844	12.689	+0.900	+0.485	—	—	—
121985	46418.99833	12.739	+0.842	+0.630	—	—	—
111588	47480.99760	12.728	+0.826	+0.562	+0.474	+0.403	+0.874
011790	47908.95287	12.715	+0.875	+0.523	—	—	—
032490	47974.79669	12.731	+0.841	+0.575	+0.460	+0.405	+0.865
031693	49062.66892	12.721	+0.854	+0.577	+0.465	+0.388	+0.854
n = 6 (UBV)	3 (RI)	12.720	+0.856	+0.559	+0.466	+0.399	+0.864
	rms error	0.018	0.027	0.050	0.007	0.009	0.010

color together with the equipment involved in acquiring those data, the errors are not large enough to indicate variability. Upon comparison with tables in Drilling and Landolt (2000), the UBV color indices of GSC 01397-00509 indicate it to be an early K dwarf, or a G5 star if a giant. The *R,I* colors appear too blue, by 0.2 magnitude in (*V–R*), though, for these spectral types. The (*V–I*) color together with the (*J–K*) color of +0.447 from Cutri *et al.* (2003) also indicates a star of spectral type late G dwarf, or early G giant (Bessell and Brett 1988).

The star marked 115 on the 17 December 1968 (revised) chart is UCAC4 541-047674 (Table 4). Correspondence between AUL and Cook (1984) agreed that its magnitude was in error. Its magnitude and color index in Table 5 herein compares well with *V* = 10.798 and (*B–V*) = +0.547, APASS magnitudes, in the UCAC4 catalog (Zacharias *et al.* 2013).

4. Summary

Calibrated *UBVRI* photometric photoelectric and CCD data for SY Cnc were obtained by the authors over a period of 22 years. The color indices of the photoelectric sequence stars encompass the colors of SY Cnc as shown in Figure 5. Although each CCD sequence star only was observed twice, there are sufficient such stars to permit appropriate calibration of CCD images. The CCD measured sequence stars also encompass the known color variations of SY Cnc. A search for a long term trend in SY Cnc's longterm average brightness was inconclusive.

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