The Variable Star HD 173637

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Abstract *UBV* photometry is presented of the emission line star HD 173637 = V455 Sct, both before and after the star's recognition as being variable in light.

1. Introduction

The star HD 173637 (R.A. = $18^h\ 46^m\ 38.081^s$, Dec. = –07° 55' 55.12", 2000) was included in a list of *UBVRI* photometric standard stars (Landolt 1983). A description containing additional information for HD 173637 was included in an Appendix to that paper. Other names for the star include BD –08 4702, MWC 607, HIP 92128, SAO 142608, AAVSO 1841–08, and ASAS 184638-0755.9. Some years later (Landolt 1993) it was realized that the "e" in the star's spectral classification B0e (Neubauer 1943) should have warned the author concerning the star's appropriateness as a standard star. Emission line stars have a habit of occasionally varying in brightness. An introductory description of such stars is given by Sterken and Jaschek (1996). The most recent spectral type of HD 173637 is B1IV (Morgan *et al.* 1955).

Observations by the author at the CTIO Yale 1.0-m telescope (Landolt 1993) found HD 173637 to be brighter than previously had been known. Therefore, the star no longer should be used as a calibrating standard star. Subsequently, the variable star designation V455 Sct was assigned to HD 173637.

Since the author has standardized multi-color photometry both before and after HD 173637 underwent a change in brightness, it was thought that publication of those data might be useful in future long term studies of the star.

2. Observations

A description of the data obtained for HD 173637 prior to its brightening were published in (Landolt 1983). Those observations were obtained during the

time interval 1978 April 11 through 1981 June 12 UT. The mean error of a single observation for the data for HD 173637 in that paper's Table I*V* was 0.015 in *V*, 0.014 in (*B–V*), and 0.014 in (*U–B*).

Subsequent to data taken prior to the star's brightening, observations were made at the Cerro Tololo Inter-American Observatory's (CTIO) Yale 1.0-m telescope [16], at the CTIO 1.5-m telescope [3], and at Kitt Peak National Observatory's (KPNO) #2 0.9-m telescope [1]. The numbers in brackets provide the number of measures made at each telescope. These data, all obtained with a photoelectric photomultiplier, covered the time interval 1993 June 25 through 2001 October 8.

The data taken prior to brightening were reduced as described in Landolt (1983). All data subsequent to the star's brightening were reduced as described in Landolt (1992). A summary of the observing and reduction philosophy is recorded in Landolt (2007). The error of a single observation, as derived from each night's standard star measurements, is listed in Table 1. These errors are directly applicable to the measurements of HD 173637 since it is of similar brightness as the standard stars.

Recent years saw the beginning of a highly successful All Sky Automated Survey (ASAS) monitoring program at Las Campanas, Chile. Information on the details of the resulting database are in (Pojmański 2002), and at http://www.astrouw.edu.pl/asas/?page=papers. One can find online at http://www.astrouw.edu.pl/asas/?page=aasc the information gleaned from the ASAS database. The star of current interest, HD 173637, appears in the ASAS database, and is identified therein as ASAS 184638-0755.9.

Pojmański (2010) provided a discussion of procedures used in the acquisition and reduction of the data which form the ASAS database. This information is available online at http://www.astrouw.edu.pl/asas/explanations.html. Following advice therein, magnitudes measured through an aperture of six pixels (MAG_4) were chosen for use here. This recommended aperture, for stars of 9th, or brighter, magnitude, corresponded to a 90-arcsec aperture.

3. Discussion

The data published in Landolt (1983), covering the time interval Heliocentric Julian Day (HJD) 2443609.87474 through 2444767.80878, indicated a brightness and color indices for HD 173637 of $V = 9.375$, $(B–V) = +0.236$, $(U–B) = –0.729$, $(V–R) = +0.168$, $(R–I) = +0.187$, and $(V–I) = +0.354$. When next observed (Landolt 1993), it was found to have brightened to $V = 8.944$ (on HJD 2449163.75847 in Table 2 herein), an increase of about 0.4 magnitude. Since then, over the time interval HJD 2449163.75847 through 2452190.56020, according to this author's observations, the star has remained near $V = 8.94 \pm 0.05$, with a slight brightening during 1995 July, near HJD 2449927, to $V = 8.87$. The data indicate that when the star brightens, it becomes redder in (*B–V*) and bluer in (*U–B*). The *V* light curve from the author's data is displayed in Figure 1.

The ASAS light curve shows an overall decline in the brightness of HD 173637 from $V = 8.78$ to 9.45 in the interval HJD 2451962.89437 to 2455136.50915. The five first and five last V magnitude data entries from the ASAS database are shown in Table 3, illustrative of the database content. These V magnitudes were taken from the MAG_4 column in the ASAS tabulation which utilized data taken through a six pixel-wide (90-arc second diameter) aperture. As written by Pojmański (2010), "the V magnitude represents a zero point adjustment, only, of observed instrumental magnitude, to place the observed instrumental magnitude onto the standard photometric system. No color correction was attempted." The third column in Table 3 gives an error for the V magnitude, not for HD 173637 per se, but an average photometric error for the frame. The light curve based on the ASAS database, and illustrated in Figure 2, shows small brightenings or outbursts, occurring at irregular intervals, at times quasi-regular, the largest of which was about 0.3 magnitude, and lasting anywhere from 286 to 1914 days, or so, as measured from beginning of brightening to the end of a slow decline. The ASAS database indicated that HD 173637 varies in brightness with a period of 93.46164 days. No periodicity is evident in either the ASAS or current data. It is likely that this period estimate came from an early, less complete, data sample (Pojmański 2010).

HD 173637 appears in the *Hipparcos Catalogue* (Perryman *et al.* 1997) as HIP 92128. These data cover the approximate Julian Day interval 2447963 to 2449058. The star exhibits an approximate 0.1-magnitude fluctuation in brightness over most of this time frame, rising some 0.25 magnitude near the end of the Hipparcos observing program. These data are summarized in ESA SP-1200, volume 11, page U43, and in ESA SP-1200, volume 8, page 1850. A light curve is shown in ESA SP-1200, volume 12, page C125. Several lines at the beginning and at the end of a subset of the Hipparcos data are given in this paper in Table 4. It should be noted that the Hipparcos times of observation are given in Barycentric Julian Days (BJD).

There is a 75-day overlap of the author's and the ASAS data sets between HJD 2452115.64 and 2452190.56. The overlapping V magnitudes for HD 173637 in the ASAS dataset are some 0.07 magnitude fainter than those in Table 2, most likely a result of the method used to set the zero point of the ASAS data. The data in Table 2 illustrate the brightening from $V \sim 9.4$ to $V \sim 8.9$. The data in Table 3 show recent behavior in the range $8.8 \leq V \leq 9.4$. Hence, HD 173637 has returned to its brightness level of 1978 April 11 UT in recent years, roughly 2005 May to 2009 November.

Figures 1, 2, and 3 provide higher resolution of the photometric behavior of HD 173637. A composite plot of the star's photometric behavior over more than 31 years is given in Figure 4. It should be noted that the Hipparcos data's Barycentric Julian Day time measurements are plotted in Figure 4 as though they were Heliocentric Julian Days, permissible since the time differences of the photometric behavior is greater than the plus or minus four seconds or so difference in a BJD or HJD time measurement.

This author's, the ASAS, and the Hipparcos data all were taken over long periods of time. In contrast, (Gutiérrez-Soto *et al.* 2007) used the COROT satellite to search for short period light variations in selected Be stars, including HD 173637. Their data allowed a search for a short-term periodicity in their 2003 dataset. (Gutiérrez-Soto *et al.* 2007) wrote that they detected "significant peaks in the frequency domain at 1.86 c d^{-1}."

4. Acknowledgements

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Table 1. RMS errors for nights containing HD 173637 data.

UT (mmddyy)	*V*	*(B–V)*	*(U–B)*	*(V–R)*	*(R–I)*	*(V–I)*
041178	0.010	0.011	0.023	0.004	0.004	0.006
060778	0.004	0.007	0.018	0.005	0.006	0.003
061078	0.006	0.008	0.015	0.003	0.004	0.003
082778	0.004	0.008	0.012	0.003	0.006	0.005
061479	0.008	0.011	0.013	0.004	0.005	0.005
061679	0.009	0.008	0.012	0.002	0.005	0.004
090980	0.010	0.011	0.023	0.003	0.006	0.004
091080	0.007	0.010	0.024	0.002	0.005	0.005
060281	0.006	0.008	0.010	—	—	—
061281	0.005	0.008	0.015	0.012	0.010	0.007
062593	0.015	0.009	0.016	—	—	—
062693	0.007	0.005	0.011	—	—	—
062793	0.007	0.007	0.028	—	—	—
070893	0.009	0.005	0.016	0.006	0.007	0.010
092493	0.009	0.010	0.028	—	—	—
092593	0.010	0.008	0.031	—	—	—
092693	0.011	0.007	0.020	—	—	—
092793	0.007	0.009	0.024	—	—	—
052594	0.006	0.012	0.023	—	—	—
070594	0.009	0.011	0.020	—	—	—
072895	0.006	0.010	0.026	—	—	—
072995	0.006	0.010	0.016	—	—	—
073195	0.004	0.008	0.020	—	—	—
030896	0.009	0.009	0.023	—	—	—
072501	0.007	0.007	0.023	—	—	—
082101	0.008	0.010	0.033:	—	—	—
100801	0.009	0.013	0.033:	—	—	—
ave.	0.0077	0.0089	0.0206	0.0044	0.0058	0.0052
±	0.0024	0.0020	0.0067	0.0030	0.0018	0.0021

Table 2. UBVRI photoelectric photometry of HD 173637.

HJD	*V*	*(B–V)*	*(U–B)*	*(V–R)*	*(R–I)*	*(V–I)*
2443609.87474	9.411	+0.271	–0.666	+0.187	+0.180	+0.367
2443609.87770	9.410	+0.264	–0.646	+0.165	+0.182	+0.347
2443666.83362	9.371	+0.238	–0.751	+0.166	+0.188	+0.354
2443666.83631	9.369	+0.235	–0.744	+0.164	+0.192	+0.357
2443669.79301	9.363	+0.224	–0.738	+0.158	+0.197	+0.354
2443669.79546	9.366	+0.220	–0.738	+0.159	+0.193	+0.351
2443747.59328	9.375	+0.234	–0.727	+0.164	+0.175	+0.338
2443747.59556	9.378	+0.230	–0.719	+0.167	+0.179	+0.344
2444038.81382	9.359	+0.236	–0.712	+0.160	+0.186	+0.346
2444038.81617	9.365	+0.230	–0.712	+0.171	+0.182	+0.353
2444040.81997	9.369	+0.244	–0.727	+0.170	+0.186	+0.355
2444040.82342	9.377	+0.224	–0.710	+0.179	+0.190	+0.369
2444491.60056	9.373	+0.232	–0.723	+0.174	+0.187	+0.361
2444492.60506	9.375	+0.238	–0.739	+0.170	+0.200	+0.369
2444757.84311	9.366	+0.219	–0.671	—	—	—
2444757.84496	9.357	+0.229	–0.680	—	—	—
2444767.80878	9.368	+0.224	–0.736	+0.164	+0.196	+0.360
2449163.75847	8.944	+0.367	–0.832	—	—	—
2449163.77291	8.960	+0.367	–0.831	—	—	—
2449164.63563	9.001	+0.360	–0.838	—	—	—
2449165.70810	8.945	+0.365	–0.827	—	—	—
2449176.79993	8.941	+0.379	–0.751	+0.315	+0.373	+0.687
2449254.55503	8.980	+0.353	–0.817	—	—	—
2449255.49769	8.974	+0.358	–0.867	—	—	—
2449256.50134	9.001	+0.360	–0.838	—	—	—
2449257.51057	8.990	+0.348	–0.841	—	—	—
2449497.82569	9.004	+0.340	–0.841	—	—	—
2449538.67485	8.945	+0.353	–0.826	—	—	—
2449926.69748	8.866	+0.386	–0.791	—	—	—
2449927.59423	8.874	+0.383	–0.835	—	—	—
2449927.59726	8.858	+0.387	–0.823	—	—	—
2449929.51739	8.885	+0.381	–0.821	—	—	—
2450150.90538	8.924	+0.394	–0.806	—	—	—
2452115.64020	8.866	+0.406	–0.800	+0.351	+0.407	+0.758
2452142.61303	8.906	+0.403	–0.792	+0.356	+0.414	+0.770
2452190.56020	8.947	+0.389	–0.786	+0.360	+0.416	+0.781

Table 3. ASAS data on HD 173637.

HJD 2450000.0+	*V*	V_{error}
1962.89437	8.782	0.047
1964.89797	8.792	0.041
1966.89386	8.813	0.038
1978.89188	8.813	0.046
1980.86618	8.790	0.044
—	—	—
—	—	—
—	—	—
5110.58556	9.392	0.074
5122.52506	9.378	0.065
5125.52060	9.358	0.075
5130.52295	9.422	0.083
5136.50915	9.451	0.082

Table 4. Hipparcos data on HD 173637.

BJD 2440000.0+	*V*	V_{error}
7963.25995	9.335	0.017
7963.33452	9.328	0.019
7989.28247	9.296	0.018
7989.29682	9.315	0.017
7989.37138	9.283	0.016
7989.38571	9.280	0.014
8010.43393	9.288	0.015
—	—	—
—	—	—
—	—	—
8932.98104	9.055	0.018
9041.11720	9.002	0.018
9041.13152	8.982	0.022
9058.51581	8.997	0.014
9058.53015	8.992	0.013
9058.68985	8.990	0.015

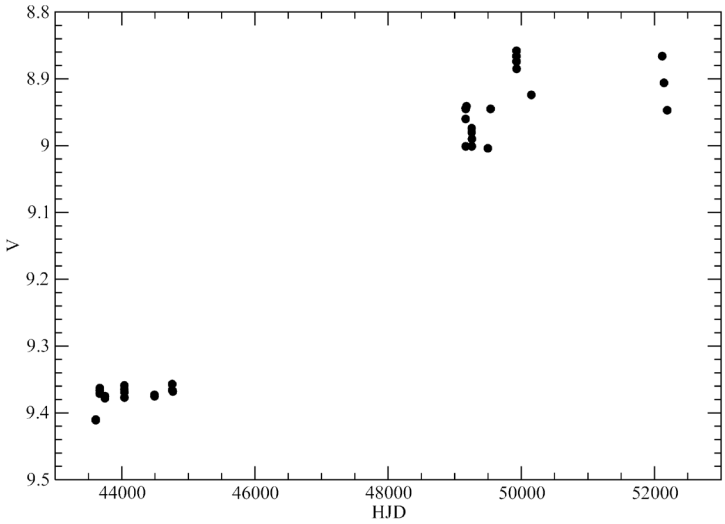

Figure 1. *V* magnitude light curve for HD 173637 based on the author's data in Table 2. To obtain the correct HJD, add 2400000.

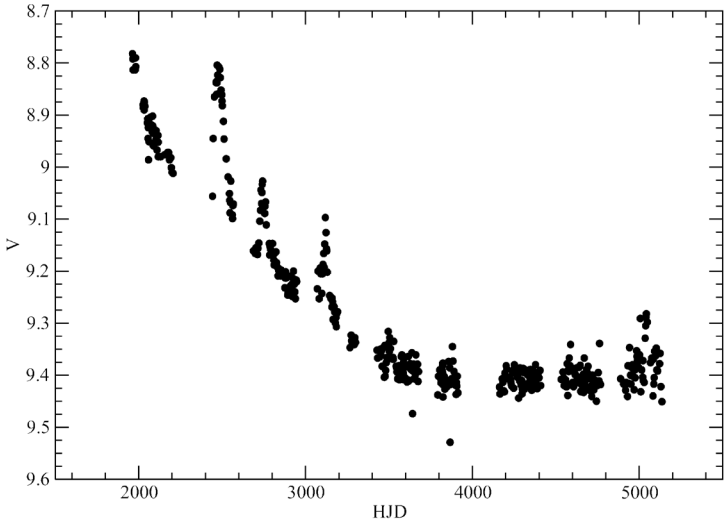

Figure 2. *V* magnitude light curve for HD 173637 based on the ASAS data in Table 3. To obtain the correct HJD, add 2450000.

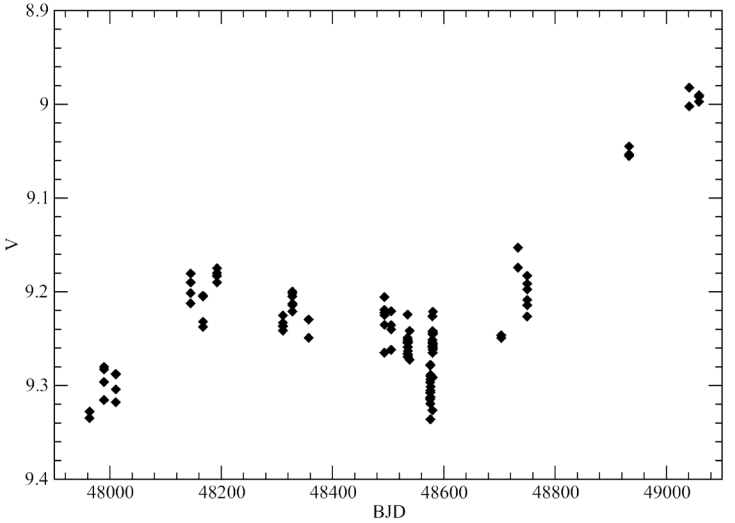

Figure 3. *V* magnitude light curve for HD 173637 based on the Hipparcos data in Table 4. To obtain the correct BJD, add 2400000.

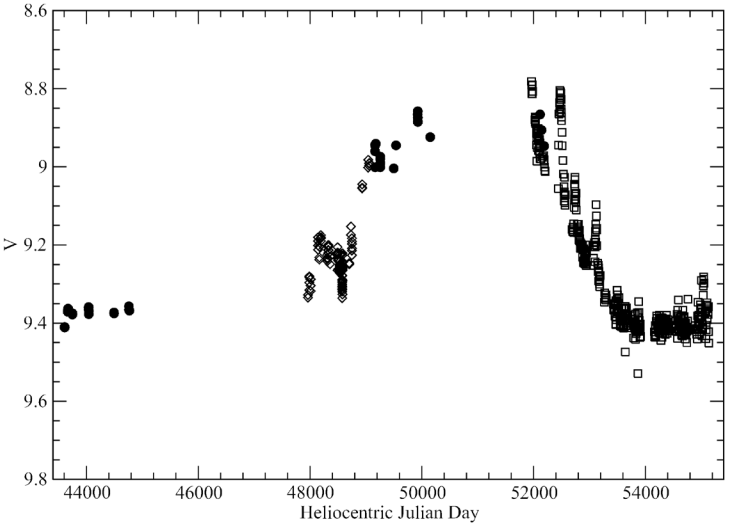

Figure 4. Composite *V* magnitude light curve for HD 173637. The data points from Table 2 (the author's) are plotted with filled circles, from Table 3 (ASAS data) with open squares, and from Table 4 (Hipparcos) with open diamonds. To obtain the correct JD, add 2400000.