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Photometry of V 1794 Cygni between 1975 and 1995*

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Abstract. Six years of new photometry of V 1794 Cyg is combined with the previously published data. These data are processed into two decades of homogeneous standard Johnson $UBVRI$ photometry, which contains 1207, 1837, 1927, 867 and 75 observations in U, B, V, R and I, respectively.

Key words: stars: individual: V 1794 Cyg (HD 199178); variables — techniques: photometric

1. Introduction

The FK Comae–type stars were defined as single and rapidly rotating G–K giants with strong chromospheric and transition region UV emission (Bopp & Rucinski 1981; Bopp & Stencel 1981). The rapidly rotating post–main–sequence star V 1794 Cyg (HD 199178, G5III-IV, $P_{\rm phot} = 3\overset{\rm d}{.}337484$, $v \sin i = 65.4$ km s^{-1}) is one of the original candidates for this class (Herbig 1958; Jetsu et al. 1990a, Paper I; Fekel 1997). V 1794 Cyg seems to have no binary companion, because the radial velocity is nearly constant (Huenemoerder 1986: $v_{\rm rad} = -27.9 \pm 1.6$ km s^{-1}). Jetsu et al. (1990b, Paper II) combined new data with all earlier photometry of V 1794 Cyg (Bopp 1982; Bopp et al. 1983; Kaluzny 1984; Nations & Seeds 1986; Huovelin et al. 1987). Those data between 1975 and 1989 were analysed in Paper I. Since then additional photometry of V 1794 Cyg have been published (e.g. Heckert & Stewart 1992; Rodono & Cutispoto 1992; Dempsey et al. 1992). We present new photometry of V 1794 Cyg made between 1989 and 1995 at the Mount Hopkins Observatory, the Mount Maidanak Observatory, the Mount Laguna Observatory, the Kvistaberg Observatory, and the Royal Swedish La Palma Observatory. This paper presents the methods applied to guarantee the homogeneity of these data between 1975 and 1995, which are analysed in Jetsu et al. (1999, Paper III). The following topics are discussed: the division of the V 1794 Cyg data into 114 subsets (SET: Sect. 2), the secondary comparison stars (C_2: Sect. 3), the primary comparison stars (C_1: Sect. 4), and the previous and the new photometry of V 1794 Cyg (Sects. 5 and 6). The photometric measurements of the primary and secondary comparison stars have been compiled into Tables 1 and 2, respectively. The necessary SET information of the V 1794 Cyg data is summarized in Table 3. Finally, the collected photometry of V 1794 Cyg is given Table 4, which is only available in electronic form (see Grewing et al. 1992).

2. Observations

The typical subset length of 30$^{\rm d}$ ensures an adequate light curve phase coverage for V 1794 Cyg. These light curves do not seem to change significantly during this time interval (Paper II). The first observing time of each subset determines the unique SET sequence for any part of collected photometry. Our Table 3 summarizes the relevant information of all 114 subsets: observing time interval, observatory, C_1, C_2, reference and number of observing nights. The collected photometry of V 1794 Cyg is

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* Table 4 is only available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/Abstract.html, http://www.edpsciences.org

Table 1. The $UBVRI$ magnitudes of all C_2, and their weighted means

U	B	V	R	I	Reference
16 Cyg B					
7.060 ± 0.026	6.860 ± 0.019	6.200 ± 0.017			Johnson & Morgan 1953
7.090 ± 0.031	6.900 ± 0.023	6.210 ± 0.022			Tolbert 1964
7.070 ± 0.019	6.880 ± 0.014	6.220 ± 0.011			Argue 1966
7.072 ± 0.043	6.855 ± 0.043	6.191 ± 0.013	5.750 ± 0.016	5.408 ± 0.016	Johnson et al. 1966
	6.898 ± 0.022	6.238 ± 0.020	5.692 ± 0.023	5.341 ± 0.027	Moffett & Barnes 1979
		6.217 ± 0.010			Tedesco et al. 1982
		6.230 ± 0.009			Olsen 1983
		6.200 ± 0.010			Campins et al. 1985
	6.910 ± 0.028	6.250 ± 0.020	5.716 ± 0.028	5.350 ± 0.028	Rakos & Franz 1988
		6.232 ± 0.004			Fabregat & Reglero 1990
		6.242 ± 0.008			Stetson 1991
	6.876 ± 0.017	6.215 ± 0.016			Turon et al. 1992
		6.238 ± 0.004			Skiff 1993
7.071 ± 0.010	6.882 ± 0.015	6.230 ± 0.013	5.728 ± 0.025	5.383 ± 0.031	Weighted mean for 16 Cyg B
57 Cyg					
	4.630 ± 0.023	4.780 ± 0.018			Ljunggren & Oja 1964
4.044 ± 0.023	4.625 ± 0.023	4.766 ± 0.022	4.833 ± 0.023	4.968 ± 0.025	Johnson et al. 1966
4.025 ± 0.023	4.635 ± 0.017	4.760 ± 0.014			Eggen 1968
4.100 ± 0.026	4.660 ± 0.021	4.800 ± 0.019			Crawford et al. 1971
		4.740 ± 0.010			Straizys et al. 1989
	4.640 ± 0.009	4.774 ± 0.007			Turon et al. 1992
4.053 ± 0.031	4.639 ± 0.009	4.766 ± 0.017	4.833 ± 0.023	4.968 ± 0.025	Weighted mean for 57 Cyg
SAO 50257					
		6.660 ± 0.010			Straizys et al. 1989
	7.554 ± 0.152	6.634 ± 0.022			Turon et al. 1992
	7.554 ± 0.152	6.656 ± 0.010			Weighted mean for SAO 50257
SAO 50326					
9.990 ± 0.010	8.730 ± 0.008	7.540 ± 0.006			McClure 1970
10.010 ± 0.027	8.720 ± 0.020	7.560 ± 0.008			Landolt 1975
		7.540 ± 0.010			Straizys et al. 1989
9.992 ± 0.007	8.729 ± 0.003	7.546 ± 0.009			Weighted mean for SAO 50326

given in Table 4. It contains the $UBVRI$ magnitudes of V 1794 Cyg (Cols. 3–7), their subset numbers and heliocentric julian dates (Cols. 1–2: SET and HJD), and the detected flares (Col. 8: F, see also Paper III: Sect. 3.1).

3. Secondary comparison stars (C_2)

The C_2 of differential photometry is observed to confirm the constant brightness of C_1, and to determine the brightness of C_1. Even for a C_2 of unknown brightness, the differential magnitudes $\Delta m_{C_1-C_2}$ can confirm the short–term constant brightness of C_1. But this does not test the long–term constant brightness of C_1. For example, a low inclination late–type spotted C_1 with long–term variability might not exhibit short–term variability. If the brightness of C_2 is known, the C_1 brightness is obtained, and the long–term constancy of C_1 can eventually be verified with respect to the other available data. It is crucial for the long–term differential photometry of any variable star (O) that the constant brightness of the chosen C_1 and C_2 combination is confirmed with high accuracy. Such a combination should be consistently used in all subsequent differential photometry of O. To achieve this goal, we compiled numerous references of the $UBVRI$ magnitudes (and errors) for all C_1 and C_2 of V 1794 Cyg (Tables 1 and 2). Furthermore, Table 2 contains new data for the two most frequently used C_1 (SAO 50313 and SAO 50205). We will show that the best combination for V 1794 Cyg would be C_2=57 Cyg with C_1=SAO 50313 or SAO 50205.

Earlier C_1 and C_2 combinations for V 1794 Cyg appear arbitrary (see Table 3). The position of V 1794 Cyg in the vicinity of the North America Nebula (NGC 7000) and the Pelican Nebula (IC 5070) offers numerous C_1 and C_2 alternatives. Four secondary (16 Cyg B, 57 Cyg, SAO 50257, SAO 50326) and three primary comparison stars (SAO 50313, SAO 50205, SAO 50260) have been used. Furthermore, the primary comparison star SAO 50313 was once used as C_2 (SET=38). The C_2 of each SET is specified in Table 3 (Col. 5), where "Absolute" denotes absolute photometry. No C_2 was observed or specified during some subsets.

3.1. Secondary comparison star 16 Cyg B

16 Cyg B (HD 186427, SAO 31899) was used as a C_2 only once (SET=28). The long–term UBV are constant (Table 1), but the RI show some scatter. The Cousins

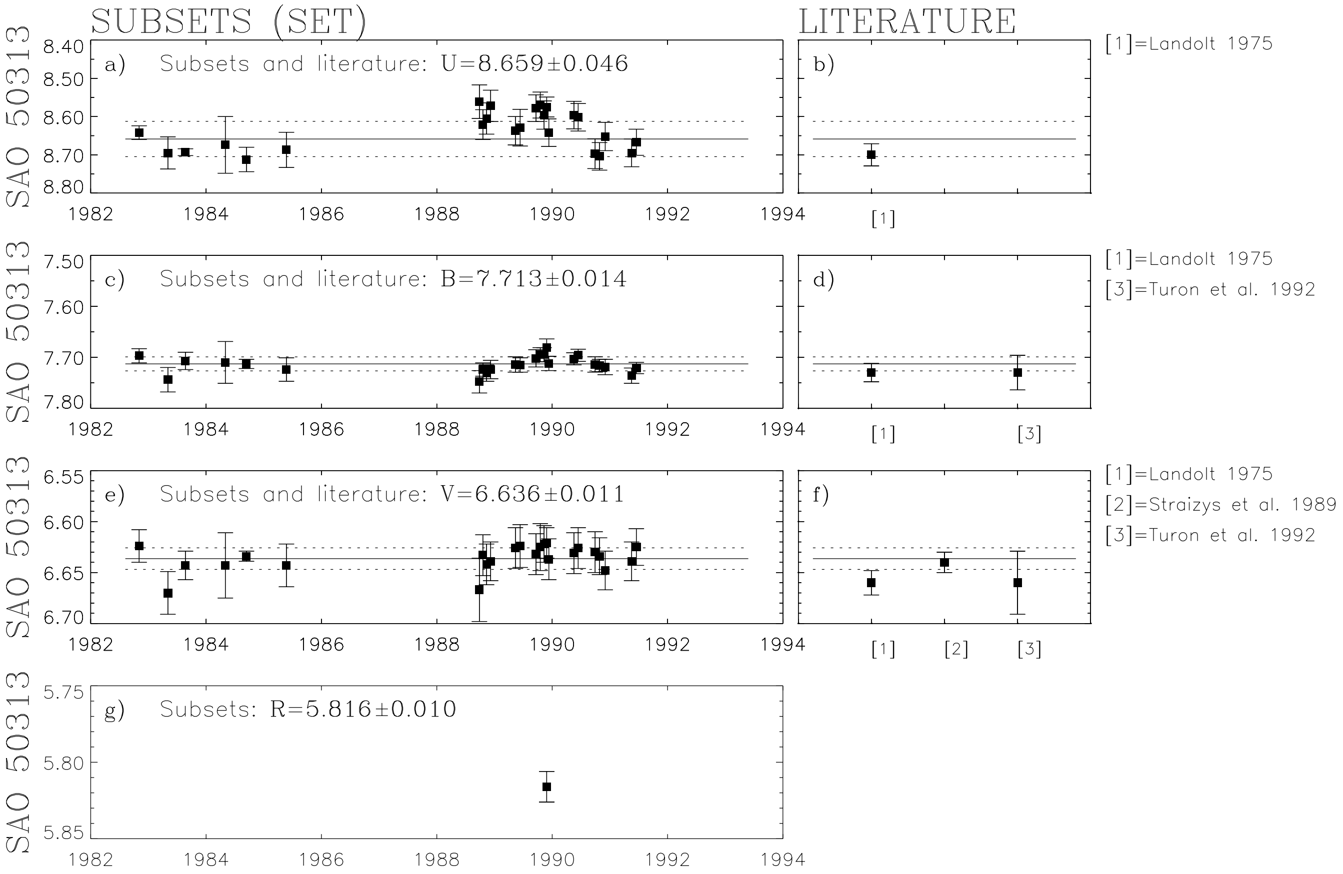

Fig. 1. aceg) The $UBVR$ magnitudes of SAO 50313 during individual subsets (Table 2: $\pm1\sigma$ errors). The weighted mean and error are outlined with the continuous and the dashed line, respectively. **bdf)** Other measurements with respect to the reference number (i.e. no epoch)

RI by Rakos & Franz (1988) transformed to the standard Johnson system (Bessell 1979) agree with Moffett & Barnes (1979). Thus the RI by Johnson et al. (1966) induce the large errors of the long–term mean RI (Table 1). 16 Cyg B is a close "solar analog"–candidate (Neckel 1986: G3V, $T_{\rm eff}$ = 5735K, $B-V = 0\overset{\mathrm{m}}{.}66$, $U-B = 0\overset{\mathrm{m}}{.}20$). Since the upper limit of the solar luminosity variations is $\pm0\overset{\mathrm{m}}{.}001$ (Willson & Hudson 1991), detection of photometric variability in this "solar analog"–candidate would be surprising. 16 Cyg B has been the standard star in many photometric studies (e.g. Moffett & Barnes 1979; Skiff 1993). The angular separation of $\Delta_{\rm sep} = 13\overset{\circ}{.}6$ between 16 Cyg B and V 1794 Cyg requires a large extinction correction, and thus it is an inconvenient C_2 for differential photometry.

3.2. Secondary comparison star 57 Cyg

57 Cyg (HD 199081, SAO 50180, $\Delta_{\rm sep} = 0\overset{\circ}{.}2$) has been the most frequently used C_2 for V 1794 Cyg. The UBV measurements indicate constant long–term brightness. But the RI have been measured only once (Johnson et al. 1966). 57 Cyg is an early–type B5V spectroscopic binary with $P_{\rm orb} = 2\overset{\mathrm{d}}{.}854825$, but *not* an eclipsing binary (Hilditch 1973; Batten et al. 1978; Giuricin et al. 1984). Since the masses are nearly equal (M_1/M_2=1.125), and the orbital inclination is $i \simeq 48°$, the upper limit for B changes is $\sim 0\overset{\mathrm{m}}{.}02$ (Hilditch 1973). The differential UBV magnitudes $\Delta m_{C_1-C_2}$ of our APT photometry revealed no periodicity with $P_{\rm orb}$, nor any significant periodicity between $0\overset{\mathrm{d}}{.}4$ and $50^{\rm d}$. Finally, we confirmed the $P_{\rm orb}$ for the $v_{\rm rad}$ data in Hilditch (1973). That 57 Cyg was successfully used as C_2 by Percy & Welch (1983) in studying the low amplitude photometric variability in early–type supergiants also supports short–term constant brightness. Our APT differential UBV photometry of SAO 50313 and SAO 50205 with respect to this C_2 confirmed constant short–term brightness. Because the UBV magnitudes are accurate and the RI magnitudes are available, we conclude that 57 Cyg is currently the best C_2 choice for V 1794 Cyg. Furthermore,

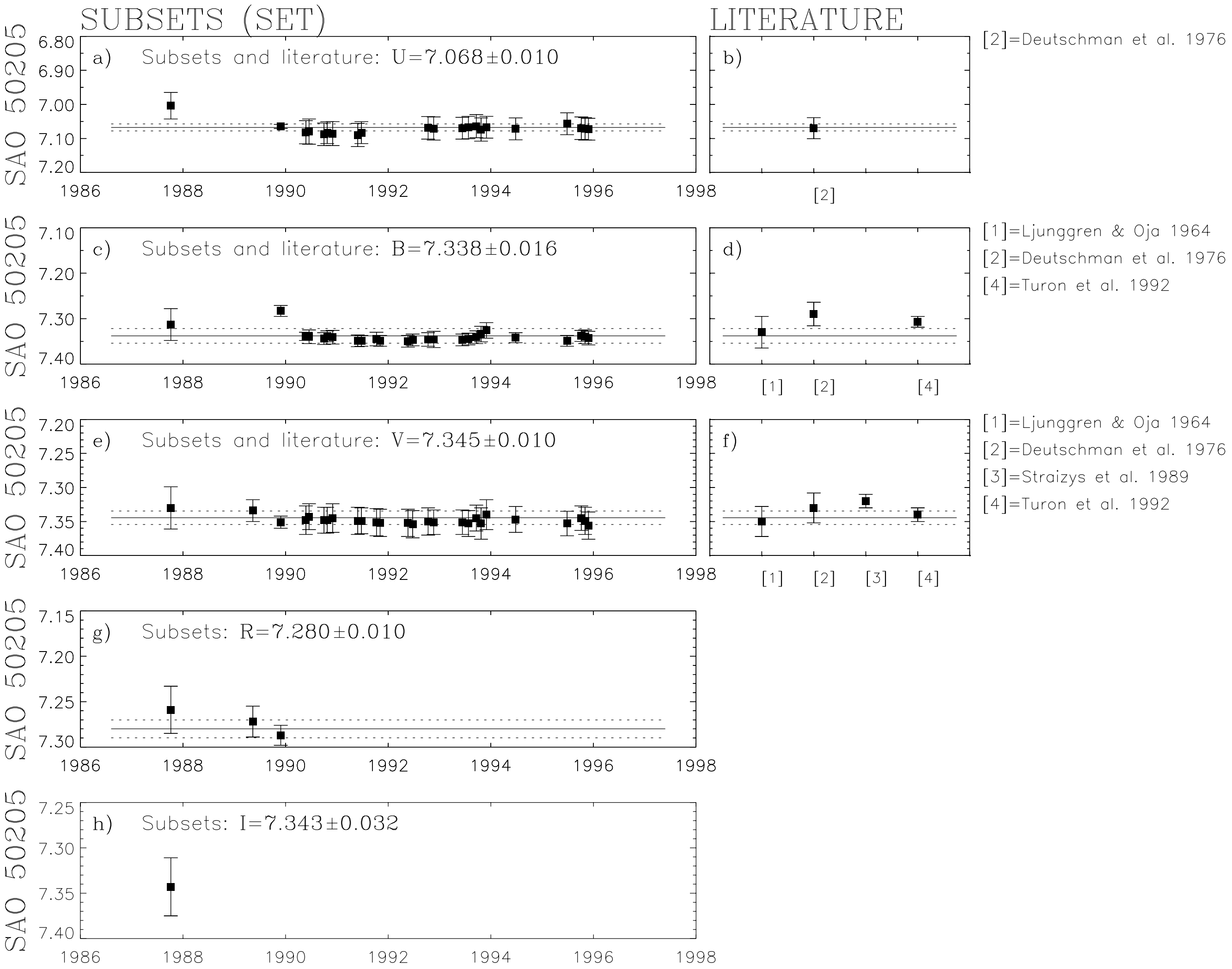

Fig. 2. The $UBVRI$ magnitudes of SAO 50205, otherwise as in Fig. 1

57 Cyg is the *only* early–type C_2 in Table 1, all others being late–type stars with convective outer envelopes possibly sustaining starspots.

3.3. Secondary comparison star SAO 50257

SAO 50257 (HD 199512, $\Delta_{\rm sep} = 1\overset{\circ}{.}7$) is a K1–2 giant or subgiant (Yoss 1961; Straizys et al. 1989). There are only two V measurements (Table 1). The single B measurement is inaccurate (Turon et al. 1992), but agrees with $B \sim m_{\rm pg} = 7\overset{\rm m}{.}6$ (Fehrenbach et al. 1987). The short–term differential magnitudes SAO 50313 minus SAO 50257 were constant (Bopp et al. 1983; Kaluzny 1984). But SAO 50257 is an unsuitable C_2, because its long–term constant brightness is uncertain, and the URI magnitudes unknown.

3.4. Secondary comparison star SAO 50326

The spectral–type of SAO 50326 (HD 200060, $\Delta_{\rm sep} = 1\overset{\circ}{.}1$) is K2III (McClure 1970; Schmitt 1971; Straizys et al. 1989). The few UBV measurements reveal no long–term variability (Table 1). Heckert & Stewart (1992) detected no short–term variability in the differential $UBV(RI)_{\rm C}$ magnitudes SAO 50313 minus SAO 50326. But this C_2 is unsuitable, because its RI magnitudes are unknown.

4. Primary comparison stars (C_1)

The C_1 of each SET is given in Table 3 (Col. 4). The two most frequently used C_1 are SAO 50313 and SAO 50205. The third one has been used only once (SET=2: SAO 50260).

4.1. Primary comparison star SAO 50313

The spectral–type estimates of SAO 50313 (HD 199956, $\Delta_{\rm sep} = 1\fdg0$) range between G8III and K1III (Häggkvist & Oja 1970; Straizys et al. 1989). The short–term constant brightness was thoroughly verified by Gonzalez B. et al. (1980: their Fig. 2), who used it as C_1 in confirming that the possible pulsations of classical Am–stars cause no detectable photometric variability. We detected no short–term variability, nor periodicity between $0\fd4$ and $50^{\rm d}$, in our new data of SAO 50313. Our measurements indicate constant long–term BV brightness (Fig. 1 and Table 2). The weighted long–term U mean is inaccurate ($\sim 0\fm046$), but comparable to the external accuracy ($\sim 0\fm03$). The $\Delta U \approx 4\fm5$ difference between 57 Cyg and SAO 50313 probably induces this scatter in the APT photometry. It may also indicate low accuracy for the transformations into the standard Johnson system. The BV remain constant during some apparently large U changes (e.g. SET=33 and 36). But UBV changes should correlate, were the U changes induced by starspots (e.g. Paper II: Fig. 3). Only one R measurement of SAO 50313 has been made, and none in I. In conclusion, the long–term constant brightness was established in BV, but not in U. The onset of photometric variability in late–type stars as a function of the Rossby number has been studied, e.g., by Hall (1991). Thus the determination of $v \sin i$ of this late–type C_1 might give a rough estimate of whether brightness variations due to starspots could even be expected.

4.2. Primary comparison star SAO 50205

SAO 50205 (HD 199206, $\Delta_{\rm sep} = 0\fdg7$) is an early–type B8II close visual binary also known as ADS 14411AB (Fehrenbach et al. 1961). Estimates of the magnitude difference and the angular separation between the A and B components range from $\Delta V = 1\fm70$ to $1\fm82$, and from $2\farcs53$ to $2\farcs80$ (Rakos et al. 1982; Turon et al. 1992). This angular separation should not cause observational errors in photometry. For example, the diaphragm diameters of the APT Phoenix 10 inch telescope at the Mount Hopkins Observatory and the AZT–14 telescope at the Mount Maidanak Observatory are $60''$ and $22''$, respectively. Our new SAO 50205 data confirm constant long–term UBV brightness with a high precision (Fig. 2). The three R measurements are in overall agreement, but the single I measurement is inaccurate. SAO 50205 has shown no short–term photometric variability (Rakos et al. 1982). No significant periodicity was detected between $0\fd4$ and $50^{\rm d}$, nor irregular short–term variability in our extensive APT data. Hence the early–type SAO 50205 is a reliable C_1 for V 1794 Cyg.

4.3. Primary comparison star SAO 50260

SAO 50260 (HD 199547, K0–2III, $\Delta_{\rm sep} = 0\fdg6$) is a long–period ($P_{\rm orb} = 2871^{\rm d} \pm 14^{\rm d}$) late–type spectroscopic binary (Fehrenbach et al. 1961; Häggkvist & Oja 1970; Griffin 1984). Short–term constant brightness has not been verified. The long–term UBV magnitudes suggest no variability, but the RI magnitudes are unknown (Table 2). SAO 50260 was used as C_1 only once (SET=2). Because the two most frequently used C_1 seem reliable (SAO 50313 and SAO 50205), using SAO 50260 as C_1 of V 1794 Cyg is unnecessary.

4.4. Long–term mean correction

The long–term mean brightness correction for any C_1 (hereafter LTM–correction) consists of two parts. *First*, the $UBVRI$ magnitudes of C_1 used in deriving the O magnitudes during any previous study are subtracted, and the "original" Δm_{O-C_1} obtained. *Then*, the corrected long–term means of C_1 are added to these Δm_{O-C_1}. Here the corrected long–term means for any C_1 of V 1794 Cyg are the weighted means of Table 2. The reasons for the LTM–correction are evident. Firstly, the improved $UBVRI$ magnitudes of C_1 are used. Secondly, consistent long–term differential photometry relies on a constant C_1 brightness. Were different $UBVRI$ magnitudes of C_1 used during different subsets, the mean brightness level of O would be inconsistent. Thirdly, C_1 is not measured during every SET. Thus the brightness must be assumed being equal to the long–term mean determined during other subsets. Our laborious C_1 and C_2 analysis for V 1794 Cyg could have been avoided, had the same combination been consistently used. In the future, only one thoroughly tested C_1 and C_2 combination should be used in the differential photometry of V 1794 Cyg. When the brightness of this combination is accurately determined, procedures like the LTM–correction become unnecessary.

5. Previous V 1794 Cyg photometry

The previously published photometry of V 1794 Cyg in our Table 4 consists of the standard Johnson $UBVRI$ photometry of Paper II and the $UBV(RI)_{\rm C}$ photometry by Heckert & Stewart (1992). These are discussed separately in Sects. 5.1 and 5.2. The first part of the APT photometry in Dempsey et al. (1992) was already published in Paper II. The numerical values of the second part of these APT data are published for the first time in our paper (i.e. the APT photometry for B.W. Bopp in Sect. 6.1). Hence the data in Dempsey et al. (1992) are referred to "This paper" in our Table 3. Apart from Rodono & Cutispoto (1992), our Table 4 contains all V 1794 Cyg photometry published before 1995.

Table 2. The $UBVRI$ magnitudes of all C_1 and their weighted long–term means. YEAR is the SET mean epoch

SAO 50313						
YEAR	U	B	V	R	I	Reference
	8.700 ± 0.029	7.730 ± 0.018	6.660 ± 0.012			Landolt 1975
			6.640 ± 0.010			Straizys et al. 1989
		7.730 ± 0.034	6.660 ± 0.031			Turon et al. 1992
1982.84	8.642 ± 0.018	7.697 ± 0.014	6.624 ± 0.016			SET= 7, Paper II
1983.34	8.695 ± 0.042	7.744 ± 0.024	6.670 ± 0.021			SET= 8, Paper II
1983.64	8.693 ± 0.009	7.707 ± 0.017	6.643 ± 0.014			SET= 9, Paper II
1984.33	8.674 ± 0.074	7.710 ± 0.041	6.643 ± 0.032			SET=11, Paper II
1984.70	8.712 ± 0.032	7.713 ± 0.009	6.634 ± 0.005			SET=13, Paper II
1985.39	8.687 ± 0.046	7.724 ± 0.023	6.643 ± 0.021			SET=14, Paper II
1988.74	8.561 ± 0.044	7.748 ± 0.022	6.667 ± 0.031			SET=33, Paper II
1988.80	8.621 ± 0.039	7.724 ± 0.013	6.633 ± 0.020			SET=34, Paper II
1988.86	8.605 ± 0.041	7.731 ± 0.016	6.642 ± 0.020			SET=35, Paper II
1988.93	8.572 ± 0.041	7.724 ± 0.018	6.639 ± 0.019			SET=36, Paper II
1989.36	8.637 ± 0.037	7.714 ± 0.015	6.626 ± 0.020			SET=37, Paper II
1989.45	8.629 ± 0.048	7.715 ± 0.014	6.624 ± 0.021			SET=39, Paper II
1989.72	8.578 ± 0.035	7.702 ± 0.017	6.632 ± 0.020			SET=43, This paper
1989.79	8.570 ± 0.034	7.695 ± 0.014	6.625 ± 0.023			SET=44, This paper
1989.86	8.596 ± 0.037	7.695 ± 0.014	6.622 ± 0.018			SET=46, This paper
1989.91	8.575 ± 0.026	7.681 ± 0.017	6.621 ± 0.015	5.816 ± 0.010		SET=47, This paper
1989.94	8.642 ± 0.036	7.712 ± 0.014	6.637 ± 0.020			SET=48, This paper
1990.38	8.596 ± 0.036	7.703 ± 0.012	6.631 ± 0.020			SET=49, This paper
1990.45	8.602 ± 0.036	7.696 ± 0.012	6.626 ± 0.020			SET=52, This paper
1990.74	8.697 ± 0.039	7.714 ± 0.015	6.630 ± 0.020			SET=57, This paper
1990.82	8.704 ± 0.036	7.716 ± 0.012	6.634 ± 0.018			SET=62, This paper
1990.92	8.652 ± 0.037	7.719 ± 0.015	6.648 ± 0.019			SET=65, This paper
1991.38	8.695 ± 0.036	7.736 ± 0.015	6.639 ± 0.019			SET=67, This paper
1991.46	8.667 ± 0.034	7.721 ± 0.011	6.625 ± 0.018			SET=70, This paper
	8.659 ± 0.046	7.713 ± 0.014	6.636 ± 0.011	5.816 ± 0.010		Weighted mean for SAO 50313
SAO 50205						
		7.330 ± 0.035	7.350 ± 0.022			Ljunggren & Oja 1964
	7.070 ± 0.031	7.290 ± 0.026	7.330 ± 0.022			Deutschman et al. 1976
			7.320 ± 0.010			Straizys et al. 1989
		7.307 ± 0.012	7.340 ± 0.010			Turon et al. 1992
1987.76	7.004 ± 0.039	7.313 ± 0.035	7.330 ± 0.031	7.259 ± 0.026	7.343 ± 0.032	SET=28, Paper II
1989.36			7.334 ± 0.016	7.272 ± 0.017		SET=38, Paper II
1989.91	7.065 ± 0.006	7.283 ± 0.012	7.351 ± 0.009	7.287 ± 0.011		SET=47, This paper
1990.40	7.082 ± 0.034	7.339 ± 0.009	7.348 ± 0.021			SET=50, This paper
1990.46	7.080 ± 0.037	7.340 ± 0.015	7.343 ± 0.019			SET=53, This paper
1990.75	7.088 ± 0.033	7.344 ± 0.013	7.348 ± 0.019			SET=58, This paper
1990.81	7.083 ± 0.032	7.339 ± 0.012	7.348 ± 0.019			SET=61, This paper
1990.92	7.086 ± 0.035	7.341 ± 0.015	7.345 ± 0.021			SET=64, This paper
1991.41	7.090 ± 0.034	7.349 ± 0.013	7.349 ± 0.020			SET=69, This paper
1991.48	7.083 ± 0.032	7.349 ± 0.012	7.349 ± 0.019			SET=71, This paper
1991.77		7.345 ± 0.015	7.351 ± 0.020			SET=76, This paper
1991.84		7.349 ± 0.012	7.352 ± 0.020			SET=79, This paper
1992.38		7.350 ± 0.013	7.352 ± 0.020			SET=80, This paper
1992.48		7.347 ± 0.013	7.354 ± 0.020			SET=82, This paper
1992.78	7.069 ± 0.033	7.346 ± 0.015	7.350 ± 0.020			SET=88, This paper
1992.89	7.071 ± 0.034	7.346 ± 0.018	7.351 ± 0.018			SET=90, This paper
1993.45	7.070 ± 0.032	7.347 ± 0.013	7.351 ± 0.018			SET=92, This paper
1993.56	7.068 ± 0.033	7.345 ± 0.013	7.353 ± 0.019			SET=95, This paper
1993.72	7.064 ± 0.034	7.341 ± 0.014	7.345 ± 0.019			SET=100, This paper
1993.81	7.074 ± 0.034	7.334 ± 0.017	7.353 ± 0.023			SET=104, This paper
1993.91	7.067 ± 0.032	7.326 ± 0.017	7.340 ± 0.022			SET=105, This paper
1994.48	7.072 ± 0.032	7.342 ± 0.011	7.347 ± 0.019			SET=106, This paper
1995.49	7.057 ± 0.032	7.349 ± 0.012	7.353 ± 0.018			SET=111, This paper
1995.76	7.070 ± 0.033	7.338 ± 0.012	7.345 ± 0.018			SET=112, This paper
1995.84	7.072 ± 0.033	7.340 ± 0.015	7.349 ± 0.020			SET=113, This paper
1995.90	7.073 ± 0.032	7.343 ± 0.015	7.356 ± 0.020			SET=114, This paper
	7.068 ± 0.010	7.338 ± 0.016	7.345 ± 0.010	7.280 ± 0.010	7.343 ± 0.032	Weighted mean for SAO 50205
SAO 50260						
	9.280 ± 0.040	8.200 ± 0.040	7.070 ± 0.040			Landolt 1975
			7.040 ± 0.010			Straizys et al. 1989
	9.230 ± 0.019	8.190 ± 0.016	7.040 ± 0.013			Oja 1991
		8.200 ± 0.034	7.070 ± 0.031			Turon et al. 1992
	9.239 ± 0.019	8.193 ± 0.004	7.043 ± 0.009			Weighted mean for SAO 50260

5.1. UBVRI photometry in Paper II

Table 3 gives the *original* reference of each SET in Paper II (Bopp 1982; Bopp et al. 1983; Kaluzny 1984; Nations & Seeds 1986; Huovelin et al. 1987; Paper II). Our LTM–correction for the three C_1 in Paper II was: *First*, the "original" Δm_{O-C_1} within each SET were obtained from the magnitudes of V 1794 Cyg (Paper II: Table 2) by subtracting the earlier C_1 magnitudes (Paper II: Table 1). *Then*, the weighted $UBVRI$ means of each C_1 from Table 2 of this paper were added to these "original" Δm_{O-C_1}. For example, the following LTM–correction was applied to the first $V_{\mathrm{old},O} = 7.225$ measurement of V 1794 Cyg on HJD = 2442719.5779. The V magnitude for SAO 50313 was $V_{\mathrm{old},C_1} = 6.653$ in Paper II. The weighted mean in our Table 2 is $V_{\mathrm{new},C_1} = 6.636$. Hence the first line in our Table 4 has

$$V_{\mathrm{new},O} = V_{\mathrm{old},O} - V_{\mathrm{old},C_1} + V_{\mathrm{new},C_1} = 7.208.$$

This particular LTM–correction is small ($0\overset{\mathrm{m}}{.}017$). But the LTM–corrections are larger for subsets with SAO 50205 as C_1: $\sim$ $0\overset{\mathrm{m}}{.}05$, $0\overset{\mathrm{m}}{.}04$, $0\overset{\mathrm{m}}{.}04$, $0\overset{\mathrm{m}}{.}02$ and $0\overset{\mathrm{m}}{.}03$ in $UBVRI$, respectively. This is partly due to the $BVRI$ magnitudes of 16 Cyg B (Moffett & Barnes 1979) that were used in Paper II to determine the brightness of SAO 50205 during SET=28. Another reason for this large LTM–correction was the inaccurate differential UB magnitudes of SAO 50205 minus SAO 50313 during SET=38 of Paper II, which have been excluded from our Table 2. On the other hand, the LTM–corrections in $UBVR$ for subsets with SAO 50313 as C_1 were between $0\overset{\mathrm{m}}{.}01$ and $0\overset{\mathrm{m}}{.}02$. Finally, SET=2 ($C_1$: SAO 50260) required a LTM–correction of only $0\overset{\mathrm{m}}{.}01$ in BV. Some minor corrections were made to the photometry of Paper II. Three possibly erroneous observations were excluded: the two V magnitudes on HJD = 2446308.8667 and 2447320.8750, and the B magnitude on HJD = 2447439.7549. In addition to these, flares were identified in four subsets of Paper II (Col. 8 of Table 4), but these will be discussed in Paper III (Sect. 3.1).

5.2. UBV(RI)$_{\mathrm{C}}$ photometry in Heckert & Stewart (1992)

Heckert & Stewart (1992) obtained differential $UBV(RI)_{\mathrm{C}}$ photometry of V 1794 Cyg during 1990 and 1991 (SET=51 and 68). Their C_1 and C_2 were SAO 50313 and SAO 50326, respectively. The standard Johnson UBV magnitudes of V 1794 Cyg were obtained by adding the SAO 50313 values from our Table 2 to the differential magnitudes. The Cousins R magnitudes were transformed into the standard Johnson system (Bessell 1979). The Cousins I could not be transformed, because the I magnitude of C_1 (SAO 50313) is unknown.

6. New V 1794 Cyg photometry

The new photometry of V 1794 Cyg was made between July, 1989 and December, 1995 at the Mount Hopkins, the Mount Maidanak, the Mount Laguna, the Kvistaberg, and the Royal Swedish La Palma Observatories (Table 3: "This paper").

6.1. Mount Hopkins Observatory (APT)

The first part of new data is the differential UBV photometry made at the Mount Hopkins Observatory between September, 1989 and December, 1995 with the (Automatic Photoelectric Telescope) Phoenix 10 inch telescope. Each observation is a mean of three ten second integrations. The average internal standard deviation of the differential magnitudes was $0\overset{\mathrm{m}}{.}008$, $0\overset{\mathrm{m}}{.}004$ and $0\overset{\mathrm{m}}{.}005$ in U, B and V, respectively. All observations with an internal error greater than $0\overset{\mathrm{m}}{.}02$ are automatically discarded by the APT. The respective external errors in UBV are $0\overset{\mathrm{m}}{.}023$, $0\overset{\mathrm{m}}{.}014$ and $0\overset{\mathrm{m}}{.}012$ (e.g. Strassmeier & Hall 1988b; Boyd et al. 1990). These external errors agree with the accuracy for the C_1 magnitudes during individual subsets of APT data (see Table 2). The APT suffered from problems with the U–band filter between July, 1991 and September, 1992. Thus only the BV–photometry of that time interval is given in Table 4. The APT observing routines have been described in detail, e.g., by Boyd et al. (1984). The C_1 for L. Jetsu was SAO 50205, while that for B.W. Bopp and H.L. Nations was SAO 50313. The long–term UBV magnitudes of these two C_1 (Table 2) were added to the differential magnitudes. The C_2 in all new APT photometry was 57 Cyg. Every SET of these new APT data has the same C_1, i.e. overlapping data with different C_1 were not combined (e.g. SET=64 and 65). This ensures the data homogeneity, and if necessary, enables simple future LTM–corrections.

6.2. Mount Maidanak Observatory

The second part of new data is absolute $UBVR$ photometry made at the Mount Maidanak Observatory between July, 1989 and September, 1994. The two most frequently used C_1, SAO 50313 and SAO 50205, were also observed in November, 1989 (Table 2: SET=47). The observations were made with the 48 cm AZT–14 telescope. Each observation in Table 4 is an average of 3–5 ten second integrations in each $UBVR$ passband. A set of standard stars was observed to determine the nightly extinction coefficients and the transformation into the standard Johnson $UBVR$ system. The upper limit of external errors for the standard Johnson BVR ($\pm 0\overset{\mathrm{m}}{.}015$) and U ($\pm 0\overset{\mathrm{m}}{.}030$) magnitudes have been determined, e.g., by Kilyachkov & Shevchenko (1976) and Shevchenko (1980), who described

Table 3. The collected photometry of V 1794 Cyg: The observing time interval, the subset number (SET), the observatory, the primary comparison star (C_1), the secondary comparison star (C_2), the reference and the number of observing nights (N)

Interval	SET	Observatory	C_1	C_2	Reference	N
3.–12.11.1975	1	McDonald Observatory	SAO 50313	–	Bopp 1982	7
5.–11.10.1976	2	Kitt Peak National Observatory	SAO 50260	–	Bopp et al. 1983	6
26.6.–17.8.1980	3	Cloudcroft Observatory	SAO 50313	SAO 50257	Bopp et al. 1983	14
12.9.–13.10.1980	4	Cloudcroft Observatory	SAO 50313	SAO 50257	Bopp et al. 1983	9
11.5.–18.6.1981	5	Cloudcroft Observatory	SAO 50313	SAO 50257	Bopp et al. 1983	4
15.9.–8.10.1982	6	Crimean Astrophysical Observatory	SAO 50205	–	Huovelin et al. 1987	10
2.–5.11.1982	7	Kitt Peak National Observatory	SAO 50313	–	Paper II	4
23.4.–31.5.1983	8	Kitt Peak National Observatory	SAO 50313	–	Paper II	6
22.–24.8.1983	9	Kitt Peak National Observatory	SAO 50313	–	Paper II	3
8.–16.9.1983	10	Crimean Astrophysical Observatory	SAO 50205	–	Huovelin et al. 1987	8
20.3.–17.5.1984	11	Kitt Peak National Observatory	SAO 50313	–	Paper II	2
17.–29.8.1984	12	Ostrowik Observatory	SAO 50313	SAO 50257	Kaluzny 1984	9
5.9.–10.11.1984	13	Kitt Peak National Observatory	SAO 50313	–	Paper II	4
30.4.–9.6.1985	14	Kitt Peak National Observatory	SAO 50313	–	Paper II	8
6.8.–4.9.1985	15	Mount Hopkins Observatory	SAO 50313	–	Nations & Seeds 1986	16
5.9.–4.10.1985	16	Mount Hopkins Observatory	SAO 50313	–	Nations & Seeds 1986	20
9.10.–1.11.1985	17	Mount Hopkins Observatory	SAO 50313	–	Nations & Seeds 1986	17
2.–22.11.1985	18	Mount Hopkins Observatory	SAO 50313	–	Nations & Seeds 1986	13
1.–27.12.1985	19	Mount Hopkins Observatory	SAO 50313	–	Nations & Seeds 1986	13
3.–29.5.1986	20	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	12
5.–20.6.1986	21	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	13
5.–17.9.1986	22	Crimean Astrophysical Observatory	SAO 50205	–	Paper II	7
28.9.–28.11.1986	23	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	16
3.–30.5.1987	24	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	9
16.6.–8.7.1987	25	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	10
11.–19.8.1987	26	Crimean Astrophysical Observatory	SAO 50205	–	Paper II	5
28.9.–27.10.1987	27	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	13
4.–12.10.1987	28	Crimean Astrophysical Observatory	SAO 50205	16 Cyg B	Paper II	5
8.11.–23.12.1987	29	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	10
25.4.–22.5.1988	30	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	16
28.5.–17.6.1988	31	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	13
5.9.–17.10.1988	32	Crimean Astrophysical Observatory	SAO 50205	–	Paper II	8
11.9.–6.10.1988	33	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	20
7.10.–1.11.1988	34	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	14
2.–21.11.1988	35	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	17
28.11.–25.12.1988	36	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	18
28.4.–27.5.1989	37	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	15
11.–15.5.1989	38	Crimean Astrophysical Observatory	SAO 50205	SAO 50313	Paper II	3
31.5.–24.6.1989	39	Mount Hopkins Observatory	SAO 50313	57 Cyg	Paper II	14
3.7.–1.8.1989	40	Mount Maidanak Observatory	Absolute	Absolute	This paper	27
2.–31.8.1989	41	Mount Maidanak Observatory	Absolute	Absolute	This paper	28
1.–30.9.1989	42	Mount Maidanak Observatory	Absolute	Absolute	This paper	22
10.–30.9.1989	43	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	11
1.–28.10.1989	44	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	12
3.–28.10.1989	45	Mount Maidanak Observatory	Absolute	Absolute	This paper	13
1.–20.11.1989	46	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	15
2.–30.11.1989	47	Mount Maidanak Observatory	Absolute	Absolute	This paper	13
23.11.–22.12.1989	48	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	11
4.–31.5.1990	49	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	11
4.5.–2.6.1990	50	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	11
16.–26.5.1990	51	Mount Laguna Observatory	SAO 50313	SAO 50326	Heckert & Stewart 1992	6
1.–26.6.1990	52	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	11
5.–26.6.1990	53	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	11
6.6.–2.7.1990	54	Mount Maidanak Observatory	Absolute	Absolute	This paper	20
8.7.–8.8.1990	55	Mount Maidanak Observatory	Absolute	Absolute	This paper	27
9.8.–9.9.1990	56	Mount Maidanak Observatory	Absolute	Absolute	This paper	26
9.9.–12.10.1990	57	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	9
10.9.–11.10.1990	58	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	9
10.–28.9.1990	59	Mount Maidanak Observatory	Absolute	Absolute	This paper	19
4.10.–7.11.1990	60	Mount Maidanak Observatory	Absolute	Absolute	This paper	15

Table 3. continued

Interval	SET	Observatory	C_1	C_2	Reference	N
12.10.–9.11.1990	61	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	17
13.10.–15.11.1990	62	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	24
8.11.–8.12.1990	63	Mount Maidanak Observatory	Absolute	Absolute	This paper	17
12.11.–19.12.1990	64	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	17
16.11.–20.12.1990	65	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	14
15.12.1990–14.1.1991	66	Mount Maidanak Observatory	Absolute	Absolute	This paper	11
30.4.–30.5.1991	67	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	15
12.–26.5.1991	68	Mount Laguna Observatory	SAO 50313	SAO 50326	Heckert & Stewart 1992	11
15.5.–8.6.1991	69	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	17
3.–30.6.1991	70	Mount Hopkins Observatory	SAO 50313	57 Cyg	This paper	20
11.6.–3.7.1991	71	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	14
11.6.–12.7.1991	72	Mount Maidanak Observatory	Absolute	Absolute	This paper	19
15.7.–15.8.1991	73	Mount Maidanak Observatory	Absolute	Absolute	This paper	26
16.8.–18.9.1991	74	Mount Maidanak Observatory	Absolute	Absolute	This paper	27
19.9.–18.10.1991	75	Mount Maidanak Observatory	Absolute	Absolute	This paper	13
29.9.–20.10.1991	76	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	18
11.10.1991	77	Royal Swedish La Palma Observatory	Absolute	Absolute	This paper	1
21.10.–25.11.1991	78	Mount Maidanak Observatory	Absolute	Absolute	This paper	13
26.10.–17.11.1991	79	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	15
6.5.–6.6.1992	80	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	13
12.–20.5.1992	81	Mount Laguna Observatory	SAO 50313	SAO 50326	This paper	6
9.6.–6.7.1992	82	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	21
15.7.–14.8.1992	83	Mount Maidanak Observatory	Absolute	Absolute	This paper	28
6.–9.8.1992	84	Mount Laguna Observatory	SAO 50313	SAO 50326	This paper	2
17.8.–18.9.1992	85	Mount Maidanak Observatory	Absolute	Absolute	This paper	23
6.–10.9.1992	86	Royal Swedish La Palma Observatory	Absolute	Absolute	This paper	4
19.9.–19.10.1992	87	Mount Maidanak Observatory	Absolute	Absolute	This paper	18
1.–23.10.1992	88	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	17
22.10.–11.11.1992	89	Mount Maidanak Observatory	Absolute	Absolute	This paper	11
2.11.–1.12.1992	90	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	11
26.11.–29.12.1992	91	Mount Maidanak Observatory	Absolute	Absolute	This paper	4
24.5.–30.6.1993	92	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	26
2.–29.6.1993	93	Mount Maidanak Observatory	Absolute	Absolute	This paper	14
6.–31.7.1993	94	Mount Maidanak Observatory	Absolute	Absolute	This paper	21
24.–27.7.1993	95	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	4
26.7.–2.8.1993	96	Mount Laguna Observatory	SAO 50313	SAO 50326	This paper	6
1.–28.8.1993	97	Mount Maidanak Observatory	Absolute	Absolute	This paper	18
5.–25.8.1993	98	Kvistaberg Observatory	Absolute	Absolute	This paper	3
30.8.–24.9.1993	99	Mount Maidanak Observatory	Absolute	Absolute	This paper	21
3.9.–3.10.1993	100	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	19
9.–10.9.1993	101	Royal Swedish La Palma Observatory	Absolute	Absolute	This paper	1
18.9.–27.10.1993	102	Kvistaberg Observatory	Absolute	Absolute	This paper	6
28.9.–28.10.1993	103	Mount Maidanak Observatory	Absolute	Absolute	This paper	17
13.10.–1.11.1993	104	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	9
21.11.–15.12.1993	105	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	9
8.6.–15.7.1994	106	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	15
13.6.–8.7.1994	107	Mount Maidanak Observatory	Absolute	Absolute	This paper	20
11.7.–5.8.1994	108	Mount Maidanak Observatory	Absolute	Absolute	This paper	21
7.8.–1.9.1994	109	Mount Maidanak Observatory	Absolute	Absolute	This paper	17
2.–28.9.1994	110	Mount Maidanak Observatory	Absolute	Absolute	This paper	14
9.6.–11.7.1995	111	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	21
21.9.–19.10.1995	112	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	22
20.10.–16.11.1995	113	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	16
17.11.–15.12.1995	114	Mount Hopkins Observatory	SAO 50205	57 Cyg	This paper	16

the Mount Maidanak Observatory photometric observing routines, instrumentation, reductions, and transformations.

6.3. Mount Laguna Observatory

The third part of new data consists of the differential $UBV(RI)_{\rm C}$ photometry made between May, 1992 and August, 1993 with the 24 inch telescope at the Mount Laguna Observatory. The comparison stars SAO 50313 (C_1) and SAO 50326 (C_2) were as in Heckert & Stewart (1992). Each observation is an average of four 10 seconds integrations through a diaphragm of $19''$ or $26''$, depending on the seeing conditions and/or background brightness. The internal error is $\leq 0\overset{\rm m}{.}01$ in every passband. The standard stars (Landolt 1983) were observed to determine the transformation into the standard Johnson UBV and Cousins RI systems. The weighted mean $UBVR$ magnitudes of SAO 50313 in Table 2 were used to derive the magnitudes of V 1794 Cyg. The Cousins R magnitudes were transformed into the standard Johnson system (Bessel 1979). The standard Johnson I magnitudes could not be derived, because I of SAO 50313 is unknown. The Mount Laguna Observatory observing routines and instrumentation have been described, e.g., in Heckert & Stewart (1992) and Heckert (1993).

6.4. Kvistaberg Observatory and Royal Swedish La Palma Observatory

The fourth part of the new data is absolute UBV photometry made between October, 1991 and October, 1993 with the 40 cm telescope at Kvistaberg Observatory and the 60 cm telescope at Royal Swedish La Palma Observatory. These observations were obtained during a survey of medium magnitude UBV standard stars at positive declinations (between 15° and 45°), i.e. V 1794 Cyg was "accidentally" included into a list of standard stars, before being identified as a variable. As an exception, the first observation (SET=77) was made during a study of late–type stars in the Milky Way. The reductions by T. Oja are essentially the same for both instruments. Each observation is a mean of three ten second integrations. The transformation into the standard Johnson UBV is determined, and continuously verified, with respect to standard star measurements, as described, e.g., by Oja (1983). The external accuracy is about $0\overset{\rm m}{.}021$ in V, and $0\overset{\rm m}{.}011$ in $B-V$ and $U-B$. The V magnitudes of V 1794 Cyg were reduced relative to three standard stars using the values given in the parenthesis: BD+44°3604 ($V = 9.420$), BD+45°3310 ($V = 8.647$), and BD+54°3220 ($V = 8.297$), while the $B-V$ and $U-B$ of V 1794 Cyg are absolute.

7. Conclusions

Achieving something comparable to the sunspot–record for any late–type star requires uninterrupted and coordinated photometric observing programs. The Ca II H&K emission measurements for about 100 solar–type main–sequence stars already extend over a quarter of a century (e.g. Wilson 1978; Saar & Baliunas 1992), and more than a decade of photometry of these stars has been made (e.g. Radick et al. 1990; Radick 1992). The necessity for long–term photometric programs for an extensive sample of all types of chromospherically active stars (e.g. pre– and post–main–sequence stars) has been emphasized, e.g., by Hall (1991). The automatic photoelectric telescopes could perform such a coordinated effort, but only smaller samples have been studied (e.g. Strassmeier & Hall 1988a,b; Henry et al. 1995). Systematic collection and easy availability of photometry obtained with automated telescopes should therefore receive utmost attention. The data time span could be extended with photographic plate archives (e.g. Hartmann et al. 1979). Very intensive photometry of V 1794 Cyg has been carried out, and our data now covers about 20 years. In observing times, the increment from Paper I is about 207%. The number of individual $UBVRI$ measurements has increased even more (∼286%).

Absolute photometry relies on a selected set of standard stars, but differential photometry requires constant brightness for C_1 and C_2. The best combination for differential photometry of V 1794 Cyg is: C_1 = SAO 50313 or SAO 50205, and C_2 = 57 Cyg. No short– or long–term photometric variability was detected in these comparison stars. Not only will this combination simplify new photometry of V 1794 Cyg, but more importantly, it ensures the homogeneity of all collected photometry. The accuracy in U for SAO 50313 is lower than for SAO 50205. The colour index difference between an early–type C_1 (i.e. SAO 50205) and a late–type variable does require secondary extinction corrections in differential photometry, especially in UB. Yet, the choice of a late–type C_1 (i.e. SAO 50313) may have unfortunate consequences. For example, Hall (1976) discusses the case, where the long–period variable HK Lac was adopted as C_1 for the RS CVn star AR Lac.

Our collection of V 1794 Cyg photometry, as well as of all C_1 and C_2, was terminated on 1995. Analysing 114 subsets would have otherwise been impossible, because any new C_1 or C_2 measurements would have required LTM–corrections in several subsets, i.e. revision of Table 4. For example, who could have foretold the planetary companion detection in one of our C_2, namely 16 Cyg B (Cochran et al. 1997)? For the purposes of our study, the "good news" about 16 Cyg B are that we used this C_2 only once, and that planetary transit detections in stellar photometry are difficult (Henry et al. 1997). Finally, it was impossible to determine the accuracy of every *individual* $UBVRI$ measurement of V 1794 Cyg in Table 4. Hence we conclude that reasonable mean external accuracy estimates for all collected photometry are $0\overset{m}{.}015$ in $BVRI$ and $0\overset{m}{.}030$ in U. A prolonged time series of homogeneous standard Johnson $UBVRI$ photometry of V 1794 Cyg has been collected and pre–processed. These data are analysed in Paper III.

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