Photometry of symbiotic stars - an international campaign

III. Z And, EG And, R Aqr, UV Aur, TX CVn, T CrB, BF Cyg, CH Cyg, CI Cyg, V 1016 Cyg, V 1329 Cyg, AG Dra, CQ Dra (4 Dra), YY Her, V 443 Her, SS Lep, RS Oph, AG Peg, AX Per, HM Sge, FG Ser (AS 296), PU Vul

A. Skopal[1], L. Hric[1], Z. Urban[1], A. Pigulski[2], C. Blanco[3], J. Papoušek[4], D. Hanžl[5], F. Agerer[6], P. Niarchos[7], H. Rovithis-Livaniou[7], P. Rovithis[7], K. Tsvetkova[8], E. Semkov[8], Z. Velič[9], F. Michálek[9], Ľ. Komačka[10], E. Schweitzer[11] and S. Korth[12]

[1] *Astronomical Institute of the Slovak Academy of Sciences, 059 60 Tatranská Lomnica, Czechoslovakia*

[2] *Astronomical Institute of the Wroclaw University, Kopernika 11, 51 622 Wroclaw, Poland*

[3] *Astronomy Institute, Catania University, I-95123 Catania, Italy*

[4] *Department of Theoretical Physics and Astrophysics, Masaryk University, Kotlářská 2, 611 37 Brno, Czechoslovakia*

[5] *N. Copernicus Observatory and Planetarium, 616 00 Brno, Czechoslovakia*

[6] *Dorfstrasse 19, DW-8311 Zweikirchen, Federal Republic of Germany*

[7] *Section of Astrophysics, Astronomy and Mechanics, Department of Physics, University of Athens, 157 83 Zografos Athens, Greece*

[8] *Department of Astronomy, Bulgarian Academy of Sciences, Trakia Blvd. 72, Sofia 1784, Bulgaria*

[9] *Rozkvet 2029/54 -43, 017 01 Považská Bystrica, Czechoslovakia*

[10] *Dadanova 3387/15, 010 04 Žilina - Hájik, Czechoslovakia*

[11] *Observatoire de Strasbourg 11, rue de l' Université 67000 Strasbourg, France*

[12] *Hindemithstrasse 10, W-4019 Monheim, Federal Republic of Germany*

Received: February 29, 1992

Contrib. Astron. Obs. Skalnaté Pleso **22**, (1992), 131– 172.

Abstract. We present new photoelectric (UBV), photographic and visual observations of 22 selected symbiotic stars. The photoelectric observations were made in 1990-91, the photographic in 1982-91, while the visual observations cover the interval 1973-1991. Some interesting results can be summarized as follows: EG And: Descending branches of the light-curve preceding primary and secondary minima were observed in U. R Aqr: Visual observations confirm the variability with the 44-year period. UV Aur: The 365-day pulsation period of the red giant was confirmed. The most conspicuous change (7.2 - 10.4 mag) was observed in the red band. BF Cyg: The eclipse of the hot component by the cool one was observed between June and September 1991. Its position allowed to determine a new average value of the orbital period equal to 759 days. CH Cyg: A sudden drop of the star's brightness in U, by about 1.5 mag lasting a few days to a few weeks was observed at the begining of July 1991. 4 Dra: An 0.30 mag increase in U, lasting about 100 days, was observed near the time of spectroscopic conjunction. V 443 Her: A minimum around JD 2 448 433 was observed in several spectral bands. AG Peg: A decrease of the star's brightness near the orbital phase 0.5 was indicated. AX Per: The primary minimum corresponding to the total eclipse of the hot component by the cool one was observed between October 27, 1990 and January 14, 1991.

Key words: stars - binaries - symbiotic - photometry

1. Introduction

This is the third paper of the series presenting the results compiled as a part of the campaign of long-term photometry of symbiotic stars (Hric and Skopal, 1989). It represents the continuation of the previous campaign's contributions (Skopal et al., 1990 - Paper I, Hric et al., 1991 - Paper II).

2. Observations

Photoelectric UBV observations were performed at the Skalnaté Pleso Observatory (hereafter SP in the tables and $*$ in the figures), at the Stará Lesná Observatory (SL, $+$), at the Observatory of the Astronomical Institute of the Wroclaw University (W, $\diamond$), at the Serra LaNave station of the Catania Astrophysical Observatory (C, $\circ$), at the Observatory of the Masaryk University in Brno (B2, $\square$), at the N. Copernicus Observatory and Planetarium in Brno (B1, $\triangle$), at the Kryonerion Station of the National Observatory of Athens (K, $\star$), and at the private station in Zweikirchen (A, $\times$). Photographic observations were made by K. Tsvetkova and E. Semkov at the Rozhen Observatory, by Z.

Velič and F. Michálek at their private station near Považská Bystrica and by L. Komačka at the Observatory in Žilina. Visual observations were collected by the members of Association Francaise des Observateurs d'Etoiles Variables - AFOEV (coordinator E. Schweitzer, denoted * in the figures), by Berliner Arbeitsgemeinschaft für Veränderliche Sterne - BAV (S. Korth, +) and by individual observers from Czechoslovakia (△).

The observations carried out at the Skalnaté Pleso Observatory, at the Observatory of the Astronomical Institute of the Wroclaw University, at the Observatory of the Masaryk University in Brno, at the N. Copernicus Observatory and Planetárium in Brno, and at the Kryonerion Station were performed in the same way as described in Paper II.

The observations at the Stará Lesná Observatory (870 m above sea level, near Tatranská Lomnica) were made with the same type of a telescope, photomultiplier and filters as in Skalnaté Pleso. The data from both observatories were reduced in a similar way.

The observations at the Catania Astrophysical Observatory were performed with a simultaneous photon counting system mounted on a 0.91 m Cassegrain telescope. The diaphragm was 2 mm, limiting the telescope field to about 28 arcsec. An EMI 9789 QA cooled photomultiplier and Schott filters UG12 - 1 mm (U), BG12 - 1 mm + GG13 - 2 mm (B) and GG14 - 2 mm (V) were used. Every measurement lasted 30 sec and was constituted by 9 counts (3 in U, 3 in B and 3 in V alternatively) with integration times of 6 sec, 2 sec and 2 sec in U, B and V respectively. Each point in the table and in the figure represents 8 to 40 measurements.

The observations at the private station in Zweikirchen were made with an 0.36 m automatic photoelectric telescope. The diaphragm was 32", an EMI 9781 B was used as photomultiplier, together with Schott filters GG495 - 1 mm (V), BG12 - 1 mm + GG385 - 2 mm (B) and UG1 - 2 mm (U). Each point in the table and figure represents 4 to 11 measurements. The observations in the U-filter are in the instrumental system.

New photoelectric observations were obtained between August, 1990 and October 30, 1991. Only these data are presented in the tables.

The photographic observations at the station near the city of Považská Bystrica were performed as described in Paper II. Some special differences, using filters, emulsions and procedures, are actually noted in the tables.

The photographic observations at the Rozhen Observatory were made with the 50/70/172 cm Schmidt telescope on the Kodak 103aO and ORWO ZU 21 plates plus GG 13 filter.

The visual observations reported in this paper consist of 43025 (AFOEV), 3827 (BAV) and 167 (Czechoslovak observers) visual magnitude estimates of 21 symbiotic stars during the years 1973 to 1991.

3. Results

The results for all the observed objects are summarized in the tables (UBV photoelectric and photographic photometry) and depicted in the figures in the case exhibiting an interesting behaviour and/or having a lot of data (visual photometry). Individual stars are described and, alphabetically arranged, in the subsections.

3.1. Z Andromedae

Photoelectric observations of this star were carried out on 6 nights. The standard stars S_1, S_2, S_3 are the same as used in Paper II. The results are compiled in Table 1 and shown in Fig. 1. Observations made during autumn 1990 show an increase of the star's brightness in all filters.

Table 1. The photoelectric observations of Z Andromedae

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
8 Aug 90	112.541	12.148	12.080	10.803	4.466	4.181	3.720^{+}	W
27 Aug 90	131.474	12.025	12.098	10.899	4.513	4.204	3.707^{+}	W
					6.652	5.277	3.892^{*}	W
12 Sep 90	147.443	11.968	12.043	10.752	4.458	4.168	3.687^{+}	W
24 Sep 90	159.443	11.935	12.005	10.734	4.481	4.193	3.701^{+}	W
12 Oct 90	177.365	11.866	11.958	10.665	4.524	4.202	3.705^{+}	W
22 Sep 91	522.469	11.817	12.079	10.723	4.541	4.161	3.679^{+}	SP
					6.904	5.304	3.842^{*}	SP

$+ S_2 - S_1$, $^{*} S_3 - S_1$

Visual observations are displayed in Fig. 2. During the outburst phase ($\sim$ JD 2 445 700 - 2 446 600) Z And reached its maximum brightness at about 8.7 mag. This visual maximum is followed by a quasi-periodic oscillations with the amplitude of 0.5 - 1 mag and the average V=10.7, typical for post-outburst behaviour of Z And (Kenyon, 1986).

3.2. EG Andromedae

UBV photoelectric observations were carried out during 44 nights. The standard stars S_1, S_2, S_3 are the same as used in the Paper II, and S_4: SAO 36597 (m_v = 8.6, m_{pg} = 9.9). The results are summarized in Table 2 and shown in Fig. 3. Our data cover the descending branches of the light-curve preceding primary and secondary minimum. Although the curves are not smooth, the star's

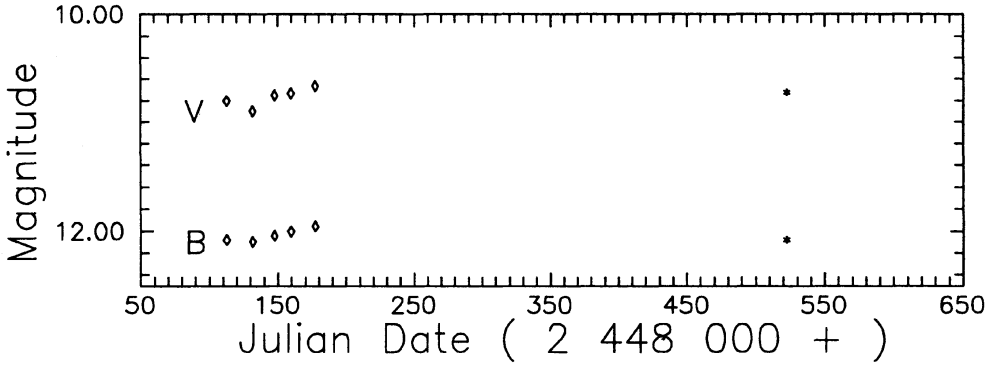

Figure 1. B and V photoelectric observations of Z Andromedae

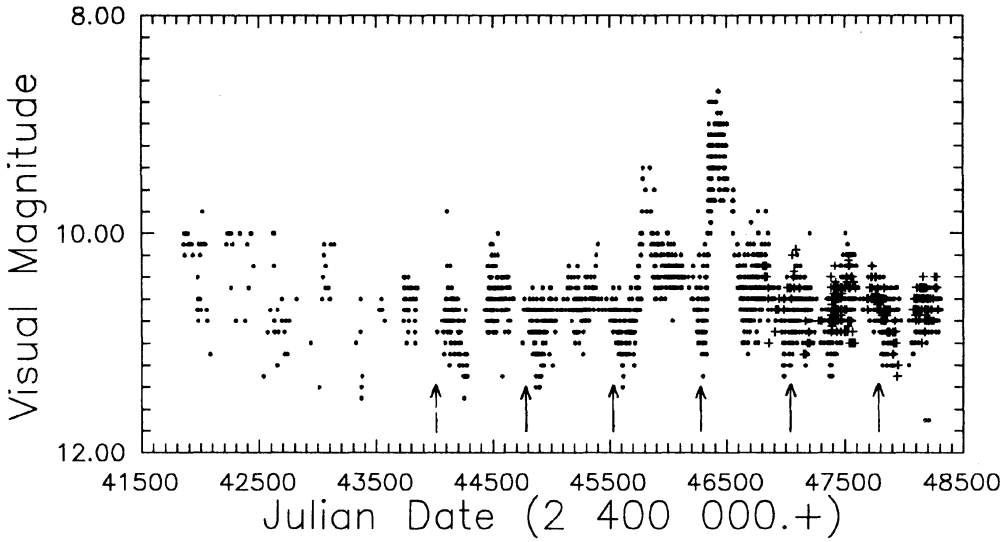

Figure 2. Visual observations of Z Andromedae. The minima predicted by Kenyon and Webbink (1984): Min_{m_v} = JD 2 421 298 + 756.85E are denoted by arrows. The observed ones are shifted by $\sim$ +150 days

brightness evidently decreases towards the minima mainly in the U-filter. Visual observations of EG And are shown in Fig. 4.

3.3. R Aquarii

Visual observations are shown in Fig. 5. Between 1974 and 1985, the periodic Mira-type variations are evidently smaller than after and before this period (cf. Kenyon, 1986, Fig. A.3). This cannot be fully explained due to the lack of data, but it can be connected with the long-period, 44-year variations proposed by

Table 2. The photoelectric observations of EG Andromedae

Date	2448...	ΔU	ΔB	ΔV	ΔU	ΔB	ΔV	Obs
8 Aug 90	112.510	-1.637	-1.412	-1.472[1]	4.415	2.598	1.542[+]	W
27 Aug 90	131.489	-1.811	-1.419	-1.465[1]	4.485	2.639	1.581[+]	W
29 Aug 90	133.559	-1.697	-1.382	-1.433[1]	4.445	2.566	1.529[+]	W
24 Sep 90	159.468	-1.765	-1.369	-1.425[1]	4.501	2.643	1.576[+]	W
3 Oct 90	167.630	-1.709	-1.405	-1.450[1]	-1.525	-0.031	0.759[#]	SP
9 Oct 90	174.530	-1.735	-1.450	-1.504[1]	4.546	2.656	1.579[+]	W
12 Oct 90	177.380	-1.603	-1.412	-1.478[1]	4.452	2.614	1.560[+]	W
14 Oct 90	179.486	-1.699	-1.413	-1.455[1]	-1.512	0.001	0.778[#]	SP
15 Oct 90	180.590	-1.713	-1.396	-1.456[1]	4.504	2.628	1.579[+]	W
25 Oct 90	190.425	-1.659	-1.371	-1.430[1]	-1.504	-0.043	0.747[#]	SP
26 Oct 90	191.485	-1.610	-1.363	-1.412[1]	-1.539	-0.036	0.741[#]	SP
15 Nov 90	211.455	-1.679	-1.313	-1.355[1]	-1.450	0.007	0.769[#]	SP
2 Dec 90	228.381	-1.617	-1.361	-1.399[1]	-1.601	-0.027	0.767[#]	SP
6 Dec 90	232.410	-1.580	-1.346	-1.411[1]	-1.444			SP
13 Dec 90	239.417	-1.538	-1.371	-1.438[1]	-1.436	0.003	0.807[#]	SP
14 Dec 90	240.422	-1.442	-1.359	-1.428[1]	-1.414	0.042	0.774[#]	SP
20 Dec 90	246.340	-1.544	-1.364	-1.427[1]	-1.519	-0.074	0.728[#]	SP
28 Dec 90	254.26	2.369	0.741	-0.337[3]	3.912	2.133	1.117*	C
28 Dec 90	254.304	-1.470	-1.334	-1.369[1]	-1.459	-0.025	0.744[#]	SP
4 Jan 90	261.29	2.389	0.755	-0.329[3]	3.930	2.139	1.115*	C
5 Jan 91	262.255	-1.643	-1.380	-1.427[1]				A
8 Jan 91	265.302	-1.579	-1.400	-1.435[1]				A
8 Jan 91	265.42	2.422	0.736	-0.334[3]	3.942	2.108	1.102*	C
9 Jan 91	266.361	-1.593	-1.394	-1.435[1]				A
11 Jan 91	268.29	2.429	0.759	-0.322[3]	3.909	2.119	1.092*	C
14 Jan 91	271.298	-1.561	-1.354	-1.390[1]				A
15 Jan 91	272.215	-1.368	-1.323	-1.396[1]	-1.481	-0.024	0.731[#]	SP
15 Jan 91	272.243	-1.524	-1.335	-1.380[1]				A
16 Jan 91	273.253	-1.500	-1.338	-1.385[1]				A
17 Jan 91	274.260	-1.528	-1.337	-1.382[1]				A
18 Jan 91	275.248	-1.547	-1.345	-1.392[1]				A
19 Jan 91	276.270	-1.554	-1.357	-1.410[1]				A
22 Jan 91	279.337		-1.385	-1.415[1]				A
24 Jan 91	281.334		-1.390	-1.431[1]				A
28 Jan 91	285.294		-1.368	-1.425[1]				A
29 Jan 91	286.32	2.451	0.776	-0.321[3]	3.929	2.102	1.068*	C
2 Feb 91	290.247	-1.310	-1.303	-1.384[1]	-1.361	0.087	0.888[#]	SP
12 Feb 91	300.29	2.494	0.825	-0.240[3]	3.913	2.091	1.110*	C
30 Jul 91	468.516	-1.654	-1.367	-1.457[1]	4.599	2.689	1.601[+]	W

Table 2 (continued)

Date	2448...	ΔU	ΔB	ΔV	ΔU	ΔB	ΔV	Obs
13 Aug 91	482.567	-1.572	-1.347	-1.431[1]	4.471	2.647	1.537+	W
24 Aug 91	492.583	-1.583	-1.299	-1.385[1]	-1.470	0.009	0.790♯	SP
3 Sep 91	503.453	-1.510	-1.238	-1.301[1]	-1.535	-0.005	0.771♯	SP
12 Sep 91	512.57	2.428	0.848	-0.173[3]	3.891	2.103	1.091*	C
23 Sep 91	522.518	-1.457	-1.364	-1.459[1]	-1.409	-0.38	0.746♯	SP
29 Sep 91	528.58	2.435	0.850	-0.173[3]	3.886	2.097	1.090*	C
17 Oct 91	546.511	-1.516	-1.332	-1.412[1]	-1.443	0.006	0.769♯	SP
6 Nov 91	566.47	2.380	0.803	-0.220[3]	3.945	2.132	1.123*	C

[1] EG And-S_1, [3] EG And-S_3, + $S_1 - S_2$, * $S_1 - S_3$, ♯ $S_4 - S_1$

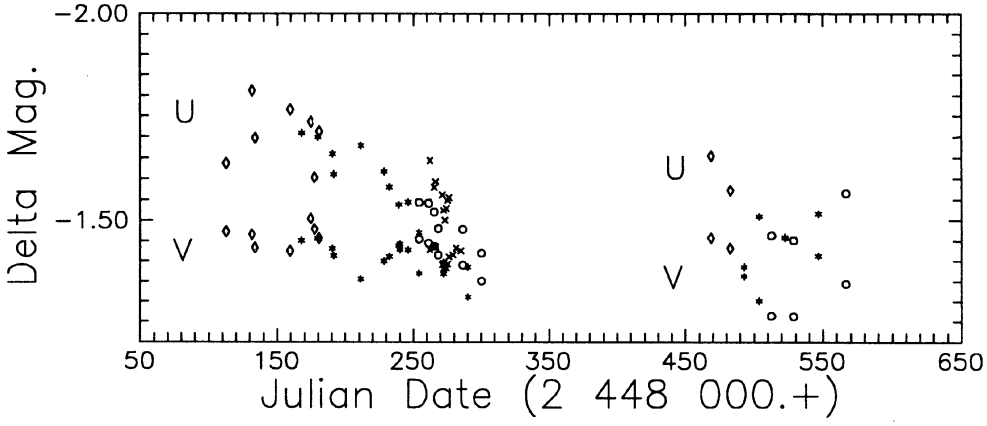

Figure 3. U and V observations of EG And. U-measurements denoted by × (Zweikirchen) are in instrumental system. Magnitude differences correspond to the EG And - S_1 values

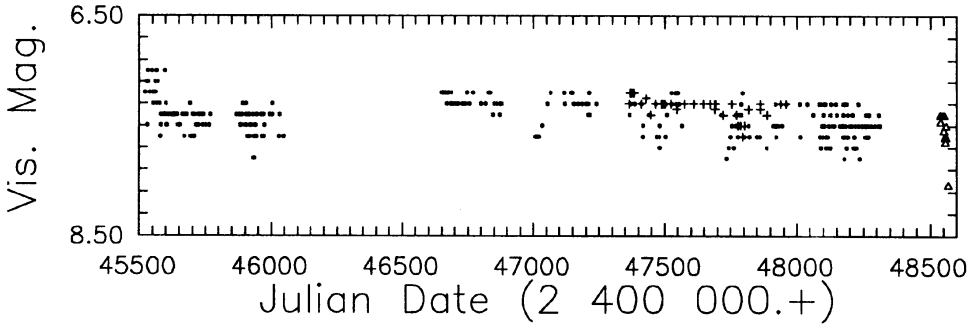

Figure 4. Visual observations of EG Andromedae

Willson et al. (1981). Moreover, the average brightness of the star also changes. At minimum (Fig. 5) it is equal to about 10 - 10.5 mag, while at maximum - to about 8 - 8.5 mag. The cause of these changes is not clear.

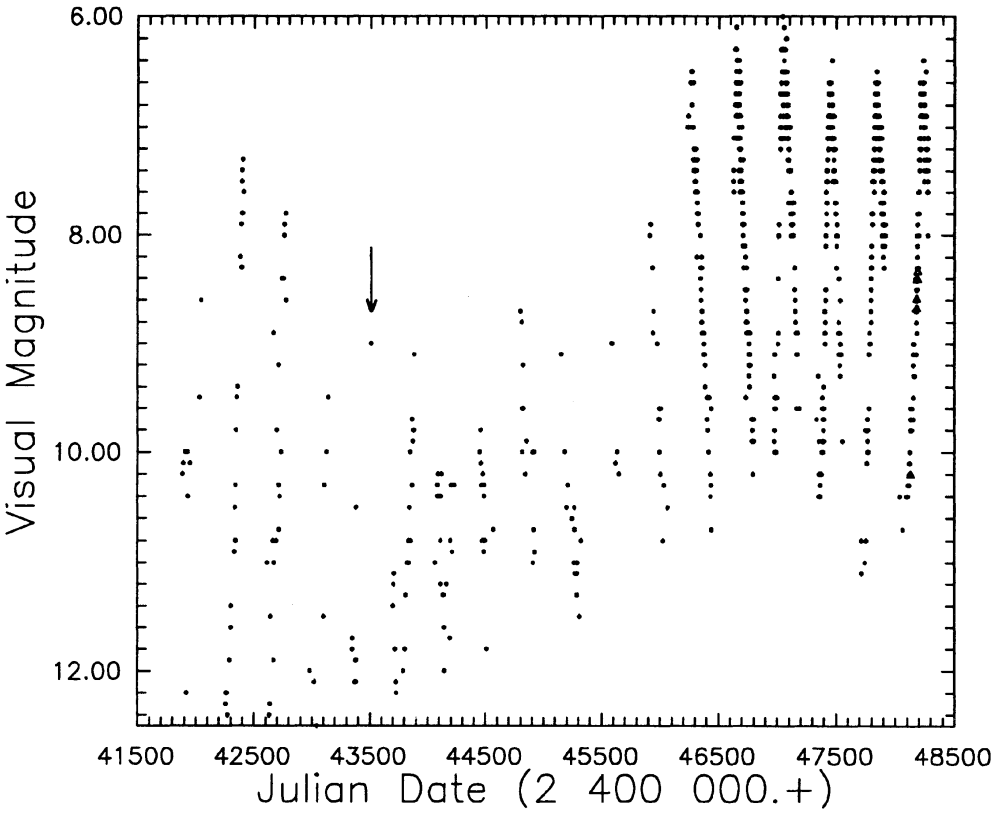

Figure 5. Visual observations of R Aquarii. Arrow at JD 2 443 500 shows the proposed minimum of the 44-year period

3.4. UV Aurigae

The photoelectric observations of this star were obtained on 16 nights. The standard stars S_1, S_2, S_3 are the same as used in Paper II. The results are compiled in Table 3 and depicted in Fig. 6. Peculiar behaviour in the star's brightness in the U-filter should be comfirmed by next observations.

The photographic observations were taken on 16 nights. The results are summarized in Table 4 together with the values remeasured from old plates published in Paper II. Fig. 7 shows our photographic photometry reflecting behaviour near the V colour. The most conspicuous change (7.2 - 10.4 mag) is

Table 3. The photoelectric observations of UV Aurigae

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
27 Aug 90	131.564	10.479	10.447	8.315	1.902	1.578	1.386^{+}	W
					0.539	1.264	1.973*	W
29 Aug 90	133.593	10.406	10.381	8.245	1.939	1.598	1.399^{+}	W
24 Sep 90	159.634	10.348	10.639	8.686	1.986	1.563	1.381^{+}	W
09 Oct 90	174.545	10.437	10.715	8.905	1.897	1.552	1.336^{+}	W
12 Oct 90	177.523	10.443	10.794	8.916	1.882	1.505	1.351^{+}	W
15 Oct 90	180.615	10.397	10.733	8.942	1.974	1.572	1.376^{+}	W
11 Nov 90	206.545	10.941	10.818	9.307	0.727	1.187	2.022*	SP
28 Dec 90	254.414	10.934	10.967	9.796	0.711	1.171	2.017*	SP
28 Dec 90	254.487	10.517	11.007	9.804	1.899	1.595	1.383^{+}	W
05 Jan 91	262.477	10.931	10.968	9.949	0.702	1.175	1.965*	SP
					2.088	1.570	1.364^{+}	SP
15 Jan 91	272.269	10.863	10.930	9.962	0.740	1.203	2.014*	SP
01 Feb 91	289.292		11.039	10.283				B1
14 Mar 91	330.350		10.929	10.299				B1
12 Apr 91	359.347	10.382	11.062	10.349	1.921	1.658	1.369^{+}	W
05 Sep 91	504.542	11.021	10.614	8.667	0.727	1.210	2.015*	SP
					2.109	1.599	1.407^{+}	SP
22 Sep 91	521.598	11.049	10.614	8.726	0.705	1.188	2.006*	SP
					2.102	1.592	1.391^{+}	SP
17 Oct 91	546.556	10.457	10.684	9.072	0.743	1.208	2.008*	SP

$+\ S_1 - S_2$, $*\ S_1 - S_3$

seen in the red band 570 - 650 (680) nm. The position of the last minimum $\sim$ JD 2 448 310 agrees with the period of 365 days already suggested in Paper II.

The visual observations (Fig. 8) exhibit periodic variations with an amplitude of $\sim$ 2 mag superimposed on the long-period modulation of the UV Aur light.

Table 4. The photographic observations of UV Aurigae

Date	2 447 ...	mag	o	b	Date	2 448...	mag	o	b
10 Feb 89	568.338	10.2	2	1	25 Aug 90	128.545	8.1	2	3
10 Feb 89	568.362	10.2	2	1	25 Aug 90	128.559	7.3	2	6
10 Feb 89	568.382	10.4	2	1	25 Aug 90	128.573	7.2	2	6
4 Mar 89	590.332	10.6	2	1	15 Oct 90	180.448	7.8	2	6
5 Mar 89	591.342	10.4	2	1	16 Oct 90	180.471	9.0	2	3
26 Mar 89	612.326	9.9	2	1	26 Oct 90	191.324	9.0	1	1*
26 Mar 89	612.351	9.9	2	1	10 Nov 90	206.366	8.3	2	6
31 Mar 89	617.309	10.3	2	1	10 Nov 90	206.387	9.5	2	3
7 Apr 89	624.328	10.2	2	1	6 Jan 91	263.278	8.6	2	6
2 Sep 89	771.557	8.6	2	1	14 Jan 91	271.283	9.2	2	6
2 Sep 89	771.570	8.8	2	1	14 Jan 91	271.306	9.8	2	3
2 Sep 89	771.584	8.6	2	1	18 Jan 91	275.318	9.6	2	6
24 Sep 89	794.447	8.6	2	1	18 Jan 91	275.340	10.4	2	3
5 Oct 89	804.471	8.8	2	1	19 Jan 91	276.301	9.9	2	6
24 Oct 89	824.435	9.3	2	1	2 Feb 91	290.286	10.0	2	6
29 Nov 89	860.326	9.8	2	1	2 Feb 91	290.311	10.1	2	6
25 Dec 89	886.289	9.6	2	1	2 Feb 91	290.349	10.3	2	3
17 Feb 90	940.258	10.2	2	1	12 Mar 91	328.343	10.1	2	7*
17 Feb 90	940.271	10.2	2	1	12 Mar 91	328.383	10.4	2	4*
17 Feb 90	940.291	10.3	2	1	13 Apr 91	360.299	9.6	2	6
21 Feb 90	944.307	10.1	1	1	13 Apr 91	360.310	9.7	2	6
22 Feb 90	945.277	10.3	2	1	15 Apr 91	362.307	9.8	2	6
22 Feb 90	945.291	10.4	2	1	9 Aug 91	477.555	9.2	2	7
23 Feb 90	946.340	10.0	1	1*	11 Sep 91	510.480	8.9	2	7
13 Mar 90	964.300	10.1	2	1	3 Oct 91	533.445	9.1	2	7
16 Mar 90	967.292	9.5	1	1	30 Oct 91	560.403	9.2	2	1
19 Mar 90	970.315	10.1	2	1	30 Oct 91	560.425	9.0	2	4
24 Mar 90	975.304	9.8	1	1*					

Observers (o): 1 Komačka
2 Velič

Sp. bands (b): 1 (400-650) nm
3 (400-680) nm
4 (570-650) nm
6 (570-680) nm
7 Agfa 400+Panchr.G3

* worse observation quality

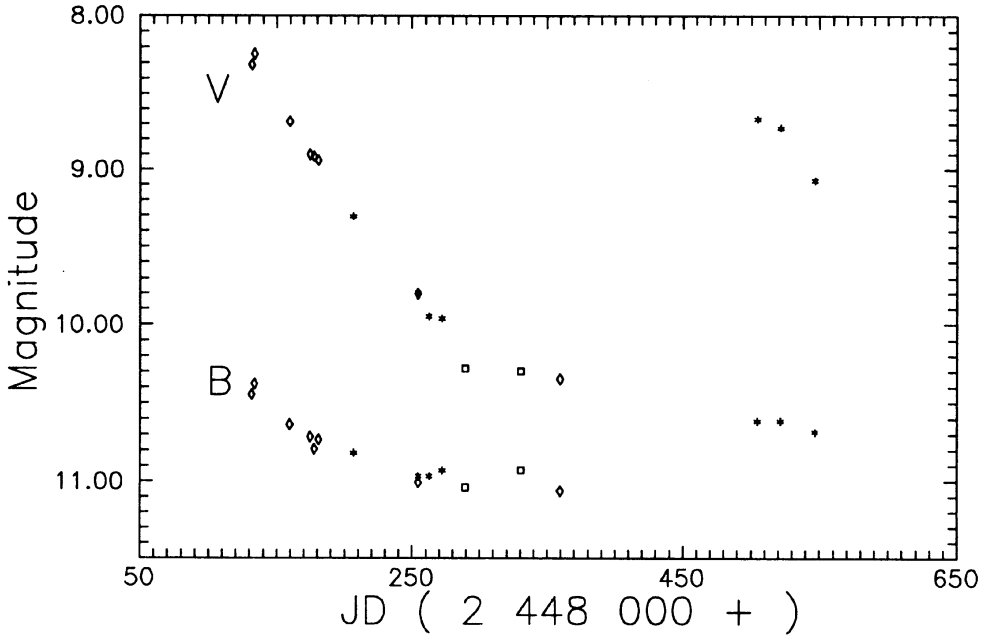

Figure 6. B and V photoelectric observations of UV Aurigae

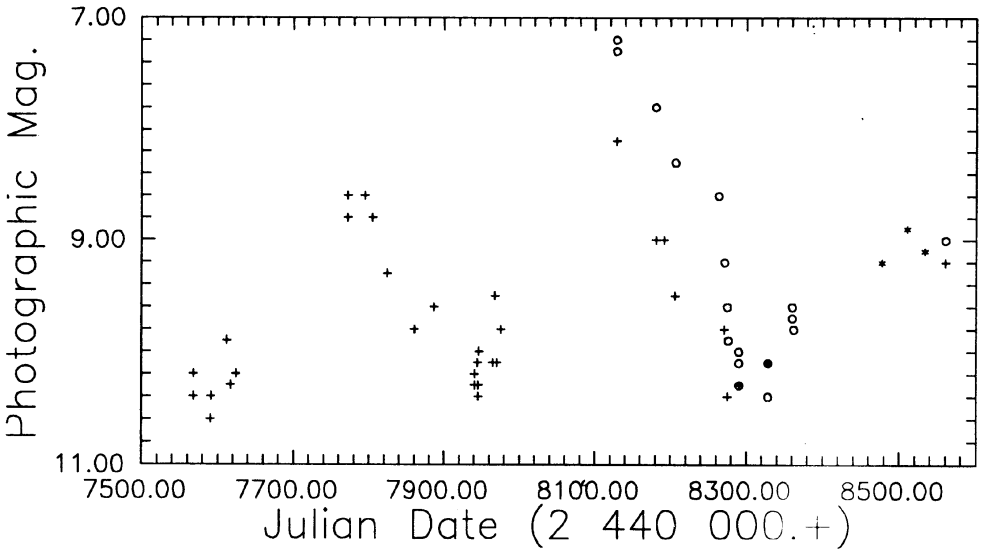

Figure 7. Photographic observations of UV Aurigae: + observations in the spectral region 400 - 650 (680) nm, o 570 - 650 (680) nm, * Agfa 400 + Panchr. G3 filter

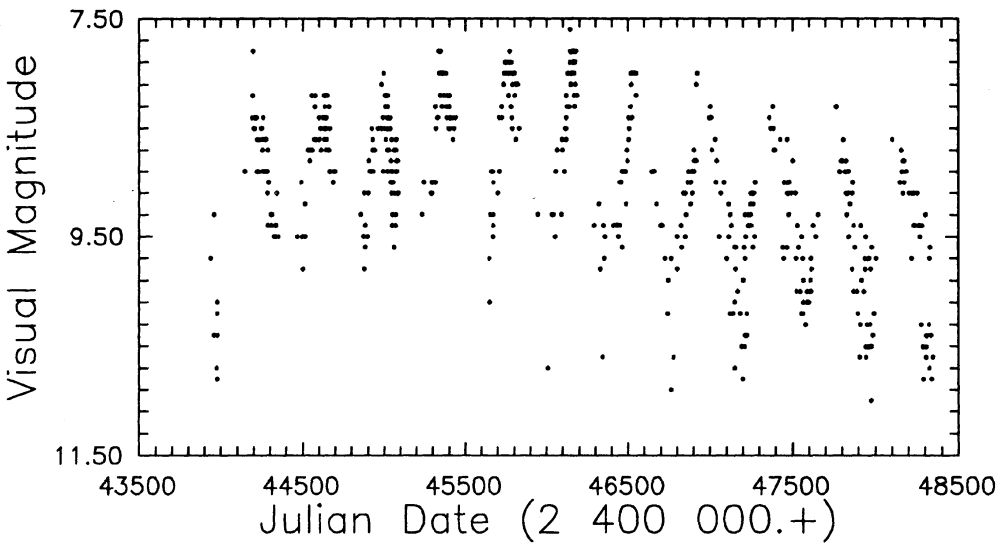

Figure 8. Visual observations of UV Aurigae

3.5. TX Canum Venaticorum

The photoelectric photometry of TX CVn was carried out on 11 nights. The standard stars S_1, S_2, S_3 are the same as used in Paper II. The results are compiled in Table 5. The visual light-curve (Fig. 9) exhibits a long-term, $\sim$ 9-year variations with the range of about 1 mag. Due to the error in visual magnitude estimation ($\sim$ 0.5 mag) it is impossible to distinguish other details.

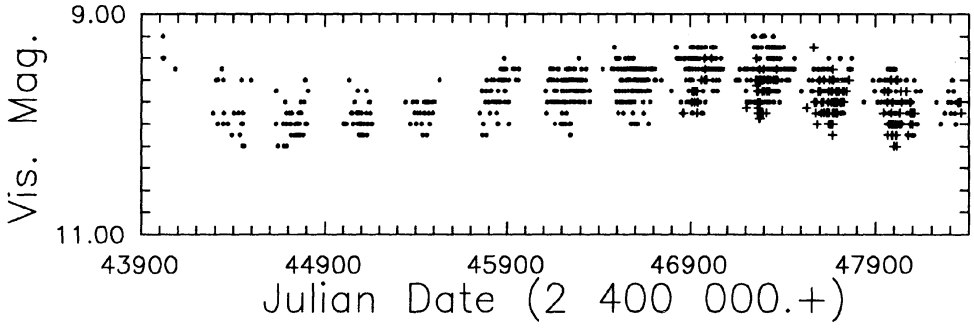

Figure 9. Visual observations of TX Canum Venaticorum

Table 5. The photoelectric observations of TX Canum Venaticorum

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
14 Mar 91	330.412		10.444	9.803				B1
16 Mar 91	332.560	10.502	10.540	9.898	-0.111	-0.045	-0.156$^+$	W
					0.956	-0.168	-1.019*	W
12 Apr 91	359.367	10.464	10.495	9.865	-0.177	-0.120	-0.195$^+$	W
					0.856	-0.269	-1.082*	W
16 Apr 91	363.602	10.233	10.618	9.290				K
18 Apr 91	365.468	10.381	10.631	9.368				K
19 Apr 91	366.588	10.642	10.713	9.333				K
20 Apr 91	367.588	10.553	10.632	9.343				K
27 May 91	404.366	10.429	10.517	9.914	-0.172	-0.088	-0.158$^+$	W
					0.854	-0.255	-1.081*	W
15 Jun 91	423.429		10.416	9.801				B1
30 Jun 91	438.383		10.343	9.800				B2
23 Jul 91	461.383	10.501	10.428	9.830	-0.257	-0.173	-0.236$^+$	W
10 Aug 91	479.341	10.495	10.436	9.973	-0.228	-0.119	-0.201$^+$	SP

$+ S_2 - S_1$, * $S_3 - S_1$

3.6. T Coronae Borealis

T CrB was observed photoelectrically on 12 nights. The standard stars S_1, S_2, S_3 are the same as used in Paper II. The measurements are included in Table 6. It is useful to note that the S_2 star is variable of the BY Dra-type (Johnson, 1986), which can be clearly seen from the values of $S_2 - S_1$ presented in Table 6. Trends of the light changes of T CrB are similar in all filters. Lack of data around the minimum (JD 2 448 328) according to the ephemeris derived from visual observations: JD(Min) = 2 435 571 + 227.8E (Paper II) do not allow us to determine it more accurate. The photographic observations are compiled in Table 7. The visual observations are shown in Fig. 10.

Table 6. Photoelectric Observations of T Coronae Borealis

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
12 Sep 90	147.279	12.038	11.338	9.908	0.827	0.185	-0.233$^+$	W
					1.945	0.291	-0.643*	W
9 Oct 90	174.228	12.138	11.464	10.072	0.956	0.235	-0.221$^+$	W
					2.089	0.323	-0.607*	W
12 Oct 90	177.226	12.124	11.456	10.105	0.967	0.253	-0.187$^+$	W
					1.978	0.226	-0.677*	W
15 Oct 90	180.224	11.912	11.489	10.157	0.775	0.166	-0.293$^+$	W
					1.885	0.277	-0.639*	W
22 Oct 90	187.212	12.376	11.615	10.234	1.033	0.307	-0.148$^+$	W
					2.001	0.300	-0.624*	W
16 Mar 91	332.576	12.459	11.765	10.364	2.020	0.357	-0.619*	W
9 Apr 91	356.466	12.711	11.347	9.973				B1
12 Apr 91	359.487	12.684	11.584	10.085	2.049	0.366	-0.590*	W
27 May 91	404.432	12.130	11.468	10.090	2.116	0.407	-0.593*	W
8 Jul 91	446.452	12.399	11.668	10.248	0.891	0.258	-0.247$^+$	SP
23 Jul 91	461.406	12.251	11.544	10.054	2.116	0.355	-0.611*	W
4 Sep 91	504.307	12.732	11.602	10.043	0.993	0.302	-0.205$^+$	SP

$+ S_2 - S_1$, * $S_3 - S_1$

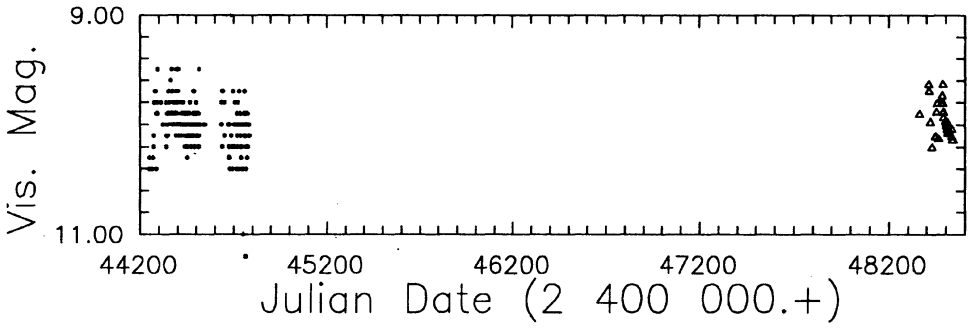

Figure 10. Visual observations of T Coronae Borealis

3.7. BF Cygni

The photoelectric observations of BF Cyg were obtained on 38 nights. The stars S_1: HD 183 650 (SAO 68384), V = 6.96, B-V = 0.71, U-B = 0.34, sp. G5 and S_2: BD+30 3594, V = 9.54, B-V = 1.20, U-B = 1.70 were used as comparisons. The results are compiled in Table 8 and depicted in Fig. 11. Our data indicate

Table 7. The photographic observations of T Coronae Borealis

Date	2448...	mag	o	b	Date	2448...	mag	o	b
19 Jun 90	062.402	10.0	1	1	2 Jun 91	410.411	9.8	1	1
14 Jul 90	087.373	10.0	1	1	9 Jun 91	417.365	9.9	1	1
22 Jul 90	095.381	10.1	1	1	12 Jun 91	420.428	10.1	3	4
28 Jul 90	101.374	10.1	3	2	22 Jun 91	430.371	9.9	1	1
28 Jul 90	101.448	9.6	3	2*	1 Jul 91	439.374	9.9	1	1
15 Aug 90	119.330	10.0	1	1	6 Jul 91	444.410	10.0	3	4
24 Aug 90	128.327	9.9	3	2	10 Jul 91	448.456	10.0	3	4*
24 Aug 90	128.341	9.9	3	2	3 Sep 91	503.321	9.9	3	4
24 Aug 90	128.362	10.0	3	2*	6 Sep 91	506.281	9.9	2	6
25 Aug 90	129.319	9.8	1	1	8 Sep 91	508.330	10.2	3	4
15 Oct 90	180.259	10.0	3	2	10 Sep 91	510.317	10.0	3	4
15 Apr 91	362.398	9.8	3	2	3 Oct 91	533.276	10.2	3	4

Observers (o): 1 Komačka
2 Komarek
3 Velič
* worse observation quality

Sp. bands (b): 1 (400-650) nm
2 (570-680) nm
4 Agfa 400+Panchr.G3
6 ORWO NP-27

continuation of the active phase. During the whole observational period BF Cyg was brightest in the U-filter. This fact corresponds to a strong interaction in the system. In October 1990 the star's brightness reached its maximum (9.35 in the U colour), in December 1990 a small gradual decrease was observed, from June to August, 1991 the brightness faded by about 1.8 mag in all filters (U $\sim$ 11.2, B $\sim$ 12.0, V $\sim$ 11.5) and in September 1991 a sudden brightenning by $\sim$ 0.9 mag was indicated. The behaviour of the light-curve in summer 1991 probably reflects an eclipse-like effect. If we combine our V-measurements with the visual magnitude estimations, we can determine the middle of this very wide ($\sim$ 110 days) minimum at JD 2 448 444. This value differs from the time of the primary minimum obtained in accord with the ephemeris Min(pg) = JD 2 415 065 + 757.3E (Pucinskas, 1970) by 58 days. Thus, the position of our primary minimum defines the new average value of the BF Cyg orbital period of 759 days. The photographic observations were taken on 14 nights and are compiled in Table 9. The visual photometry of BF Cyg is shown in Fig. 12.

Table 8. Photolelectric Observations of BF Cygni

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
8 Aug 90	112.492	9.539	10.210	9.780	4.398	3.243	2.555^{+}	W
27 Aug 90	131.393	9.517	10.184	9.754	4.538	3.252	2.560^{+}	W
12 Sep 90	147.374	9.475	10.158	9.748	4.570	3.261	2.539^{+}	W
17 Sep 90	152.441	9.411	10.139	9.765				SP
24 Sep 90	159.360	9.423	10.113	9.696	4.482	3.221	2.530^{+}	W
3 Oct 90	168.406	9.331	10.084	9.732				SP
9 Oct 90	174.418	9.450	10.177	9.754				SP
12 Oct 90	177.301	9.579	10.243	9.803	4.531	3.253	2.567^{+}	W
15 Oct 90	180.294	9.374	10.167	9.827				SP
23 Oct 90	188.295	9.441	10.194	9.866				SP
24 Oct 90	189.265	9.456	10.192	9.849				SP
25 Oct 90	190.234	9.379	10.128	9.767				SP
25 Oct 90	190.270	9.459	10.213	9.825				SL
26 Oct 90	191.260	9.349	10.052	9.753				SP
6 Dec 90	232.199	9.487	10.281	9.931	4.686	3.330	2.547^{+}	SP
8 Dec 90	234.193	9.585	10.350	9.951	4.608	3.309	2.572^{+}	SP
23 Dec 90	248.220	9.697	10.474	10.066	4.414	3.183	2.520^{+}	SL
16 Mar 91	332.628	10.819	11.191	10.589	4.338	3.161	2.499^{+}	W
12 Apr 91	359.535	10.333	10.696	10.118	4.594	3.236	2.540^{+}	W
9 Jun 91	417.498	11.368	12.014	11.469	4.647	3.282	2.517^{+}	SP
15 Jun 91	422.506	11.352	11.956	11.505	4.638	3.296	2.524^{+}	SP
21 Jun 91	428.510	11.419	12.014	11.529	4.688	3.200	2.494^{+}	SP
26 Jun 91	433.505	11.437	12.054	11.573	4.444	3.240	2.510^{+}	SP
6 Jul 91	444.477	11.383	12.031	11.528	4.728	3.285	2.562^{+}	SP
22 Jul 91	460.478	11.484	12.150	11.597	4.523	3.275	2.528^{+}	SP
23 Jul 91	461.461	11.665	12.215	11.672	4.413	3.219	2.523^{+}	W
30 Jul 91	468.457	11.826	12.305	11.743	4.495	3.291	2.605^{+}	W
6 Aug 91	475.447	11.388	12.013	11.516	4.419	3.279	2.547^{+}	SP
7 Aug 91	476.467	11.412	11.997	11.496	4.503	3.275	2.537^{+}	SP
13 Aug 91	482.474	11.710	12.234	11.601	4.486	3.220	2.533^{+}	W
22 Aug 91	491.346	11.350	11.917	11.405	4.770	3.246	2.533^{+}	SP
31 Aug 91	500.402	11.360	11.962	11.400	4.717	3.276	2.539^{+}	SP
2 Sep 91	502.335	11.607	12.186	11.525	4.494	3.279	2.548^{+}	W
2 Sep 91	502.356	11.358	11.941	11.378	4.513	3.267	2.548^{+}	SP
21 Sep 91	521.378	10.242	11.077	10.517		3.259	2.521^{+}	SP
28 Sep 91	528.315	10.230	11.130	10.490	4.485	3.277	2.543^{+}	SP
1 Oct 91	531.292	10.173	11.117	10.512	4.704	3.281	2.556^{+}	SP
7 Oct 91	537.264	10.297	11.313	10.638	4.639	3.278	2.550^{+}	SP
25 Oct 91	555.368	11.697	11.294	10.616		3.187	2.488^{+}	SP
29 Oct 91	559.340	11.770	11.356	10.681	4.689	3.277	2.551^{+}	SP

$+ S_2 - S_1$

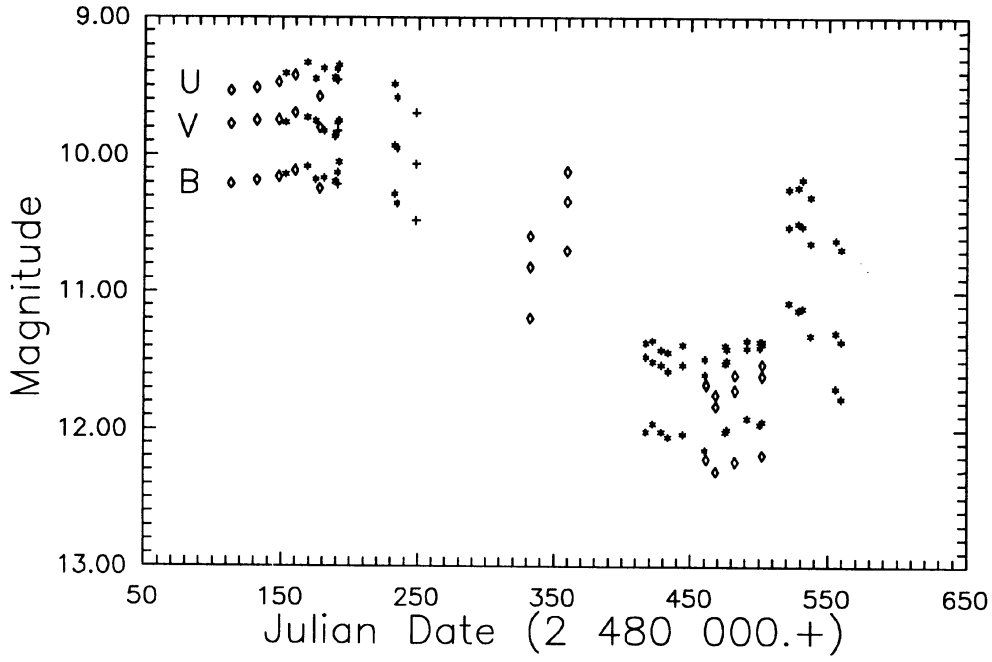

Figure 11. Photoelectric observations of BF Cygni

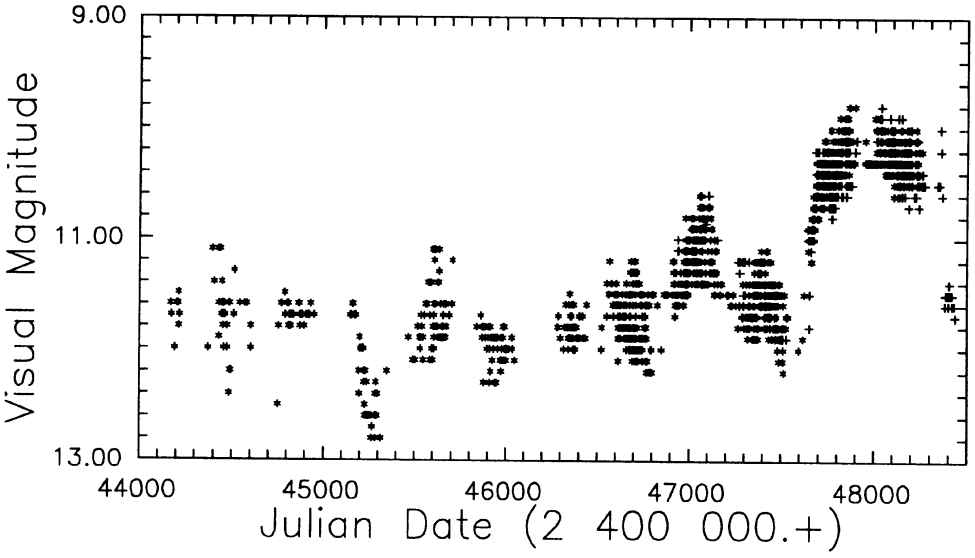

Figure 12. Visual observations of BF Cygni

Table 9. Photographic observations of BF Cygni

Date	2 448...	mag	o	b	Date	2448...	mag	o	b
12 Jul 90	085.379	9.7	1	1	23 Oct 90	188.236	9.7	1	1
20 Jul 90	093.465	9.7	1	1	2 Jun 91	410.460	10.9	1	1
28 Jul 90	101.375	9.7	1	1	23 Jun 91	430.487	11.1	1	1
13 Aug 90	117.392	9.5	1	1	5 Jul 91	443.463	10.4	1	1
24 Aug 90	128.319	9.8	1	1	7 Aug 91	476.455	10.5	1	1*
20 Sep 90	155.306	9.7	1	1	10 Sep 91	510.345	9.6	1	1
9 Oct 90	174.264	9.7	1	1	7 Oct 91	537.293	9.7	1	1

Observers: 1 Komačka Sp. bands: 1 (400-650) nm
* worse observation quality

3.8. CH Cygni

This star was observed photoelectrically on 56 nights. The standard stars S_1, S_2, S_3 are the same as used in Paper II. The star S_4: HD 184 293, V = 5.53, B-V = 1.25, U-B = 1.18 was used as comparison at the B2 station. We do not recommend the use of standard S_1 as already pointed out in Paper II. Our measurements are compiled in Table 10, and the U,V light-curves shown in Fig. 13. As in 1989, CH Cyg faded again to $\sim$ 10.3 in the U-filter in September 1990 after a few months of brightening. From October, 1990 to June 26, 1991 CH Cyg preserved its brightness in the U band near 10.2, at the begining of July, 1991 a sudden drop of the star's brightness in the U-filter by about 1.5 mag was observed independently at the three observatories (Fig. 13). This event lasted a few days to weeks. It was the lowest value of the CH Cyg brightness observed during the whole history of the photoelectric observations of this star. Then the U light-curve exhibited short-term oscillations of $\Delta U \sim 0.3$ - 0.7 mag with a gradual decrease. On the contrary, the V light-curve was relatively smooth exhibiting a slight increase during the U-drop period. The visual observations are shown in Fig. 14

3.9. CI Cygni

The star was observed photoelectrically on 7 nights. The standard stars S_1, S_2 are the same as used in Paper II. The results are summarized in Table 11 and shown in Fig. 15. The trend of the change in the star's brightness probably corresponds to the descending branch of the light-curve before the primary minimum. The visual observations are displayed in Fig. 16.

Table 10. Photoelectric observations of CH Cygni

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
19 Jun 90	062.423		10.249	8.824				K
20 Jun 90	063.373		10.470	8.960				K
27 Jun 90	069.506	10.222	10.233	8.807				B1
29 Jun 90	072.462	9.875	9.968	8.696				B1
08 Aug 90	112.399	9.336	9.844	8.603	2.676	2.361	1.828	W
08 Aug 90	112.481	9.481	9.831	8.624	2.733	2.359	1.828	W
27 Aug 90	131.443	9.106	9.777	8.661	2.649	2.372	1.828	W
27 Aug 90	131.523	9.168	9.769	8.646	2.660	2.375	1.836	W
29 Aug 90	133.542	9.892	10.124	8.704	2.716	2.349	1.803	W
12 Sep 90	147.412	10.036	10.231	8.786	2.662	2.379	1.826	W
12 Sep 90	147.418	10.112	10.253	8.768	2.654	2.381	1.831	W
17 Sep 90	152.478	10.251	10.129	8.682				SP
24 Sep 90	159.373	10.363	10.299	8.711	2.699	2.405	1.838	W
24 Sep 90	159.452	10.290	10.289	8.711	2.705	2.382	1.845	W
03 Oct 90	167.510	10.587	10.302	8.679	2.694	2.385	1.815	SP
03 Oct 90	168.453	10.491	10.271	8.676	2.684	2.378	1.817	SP
09 Oct 90	174.252	10.400	10.330	8.743	2.665	2.417	1.871	W
10 Oct 90	175.468	10.340	10.263	8.666	2.689	2.374	1.785	SP
12 Oct 90	177.261	10.484	10.335	8.731	2.730	2.406	1.851	W
12 Oct 90	177.341	10.402	10.374	8.723	2.648	2.365	1.843	W
12 Oct 90	177.425	10.383	10.332	8.731	2.696	2.402	1.870	W
12 Oct 90	177.466	10.360	10.265	8.717				SP
15 Oct 90	180.245	10.109	10.190	8.697	2.679	2.380	1.826	W
15 Oct 90	180.348	10.439	10.279	8.704	2.702	2.387	1.814	SP
22 Oct 90	187.231	10.066	10.298	8.768	2.663	2.383	1.838	W
23 Oct 90	188.331	10.537	10.363	8.764	2.695	2.392	1.825	SP
25 Oct 90	190.333	10.250	10.289	8.766	2.695	2.398	1.820	SP
06 Dec 90	232.324	10.007	10.260	8.959				SL
06 Dec 90	232.325	10.117	10.388	9.006	2.703	2.386	1.803	SP
28 Dec 90	254.233	10.207	10.435	8.951	2.674	2.371	1.849	SP
16 Mar 91	332.607	10.185	10.487	8.869	2.650	2.328	1.739	W
17 Mar 91	333.626	10.236	10.413	8.862	2.706	2.396	1.796	SP
12 Apr 91	359.522	10.343	10.550	8.859	2.664	2.346	1.827	W
12 Apr 91	359.567	10.365	10.571	8.857	2.685	2.352	1.800	W
09 May 91	385.520	10.099	10.362	8.759	2.718	2.417	1.848	SP
02 Jun 91	409.513	10.177	10.338	8.696	2.729	2.399	1.834	SP

Table 10 (continued)

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
09 Jun 91	417.446	10.012	10.214	8.647	2.682	2.357	1.807♯	SP
12 Jun 91	420.462	9.696	10.060	8.575	2.668	2.391	1.815♯	SP
15 Jun 91	423.390	9.909	10.021	8.565	2.680	2.376	1.826♯	SL
20 Jun 91	428.459	9.737	9.981	8.476	2.763	2.435	1.873♯	SP
25 Jun 91	433.385		9.589	8.189				K
27 Jun 91	435.508		9.620	7.950				K
28 Jun 91	436.409		9.813	8.147				K
28 Jun 91	436.416	9.922	10.049	8.446	2.700	2.393	1.825♯	SP
06 Jul 91	443.525	11.839	10.642	8.565	2.708	2.390	1.817♯	SP
06 Jul 91	444.403	11.815	10.594	8.619	2.662	2.356	1.837♯	SL
10 Jul 91	448.442	11.807	10.321	8.355				B1
11 Jul 91	449.395	11.593	10.117	8.224				B1
12 Jul 91	450.404	11.901	10.549	8.551	2.697	2.319	1.795♯	SL
23 Jul 91	460.529	10.825	10.346	8.524	2.699	2.396	1.822♯	SP
23 Jul 91	461.368	10.938	10.549	8.577	2.772	2.385	1.836♯	W
23 Jul 91	461.422	10.861	10.490	8.562	2.662	2.360	1.813♯	W
24 Jul 91	461.507	10.748	10.477	8.561	2.696	2.388	1.823♯	W
30 Jul 91	468.435	10.190	10.241	8.516	2.694	2.386	1.817♯	W
31 Jul 91	468.555	10.143	10.139	8.470	2.685	2.373	1.819♯	W
06 Aug 91	475.493	10.477	10.327	8.602	2.700	2.405	1.836♯	SP
13 Aug 91	482.493	10.397	10.418	8.705	2.693	2.404	1.830♯	W
14 Aug 91	482.552	10.219	10.275	8.676	2.699	2.371	1.810♯	W
23 Aug 91	492.460	10.533	10.323	8.684	2.700	2.380	1.817♯	SP
31 Aug 91	500.361	10.258	10.168	8.600	2.699	2.390	1.830♯	SP
02 Sep 91	502.323	10.310	10.260	8.616	2.746	2.403	1.837♯	W
03 Sep 91	503.303	10.741	10.385	8.641	2.703	2.392	1.816♯	SP
06 Sep 91	506.360	10.150	10.120	8.610				B2
10 Sep 91	510.320	10.792	10.317	8.647				B2
21 Sep 91	521.290		10.349	8.522				B2
21 Sep 91	521.472	11.532	10.485	8.476	2.680	2.389	1.831♯	SP
25 Sep 91	525.294	10.976	10.265	8.479				B2
01 Oct 91	531.333	10.719	10.085	8.282	2.701	2.391	1.824♯	SP
03 Oct 91	533.260	10.330	9.980	8.325				B2
07 Oct 91	537.250	10.817	10.207	8.407				B2
08 Oct 91	538.250	11.426	10.381	8.387	2.702	2.397	1.825♯	SP
25 Oct 91	555.420	11.512	10.523	8.591	2.691	2.396	1.853♯	SP
29 Oct 91	559.379	11.665	10.646	8.618	2.687	2.383	1.828♯	SP
30 Oct 91	560.244	11.477	10.582	8.706				B2

♯$S_2 - S_3$

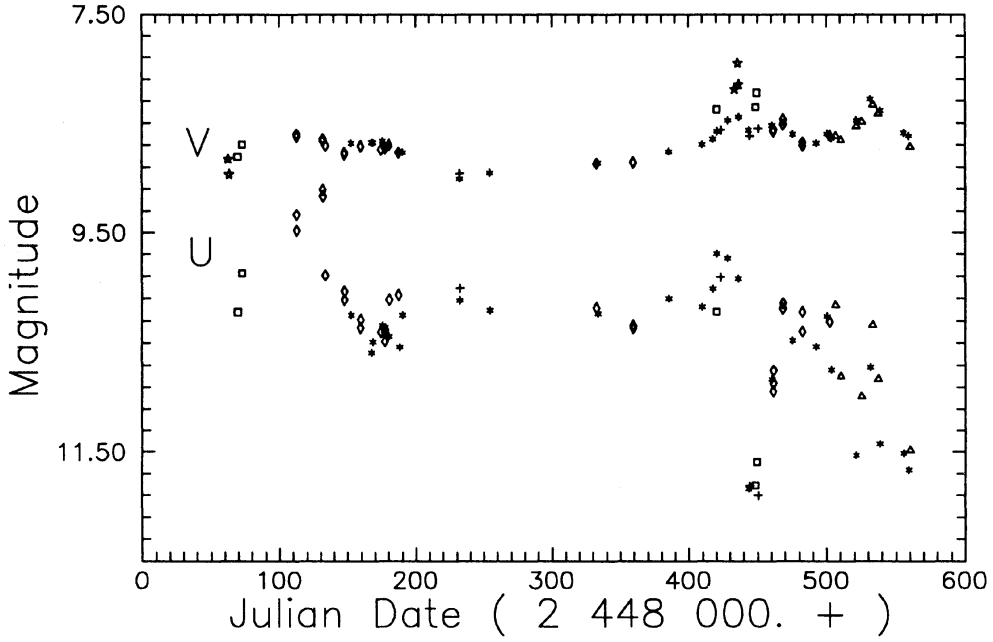

Figure 13. U and V light-curves of CH Cygni

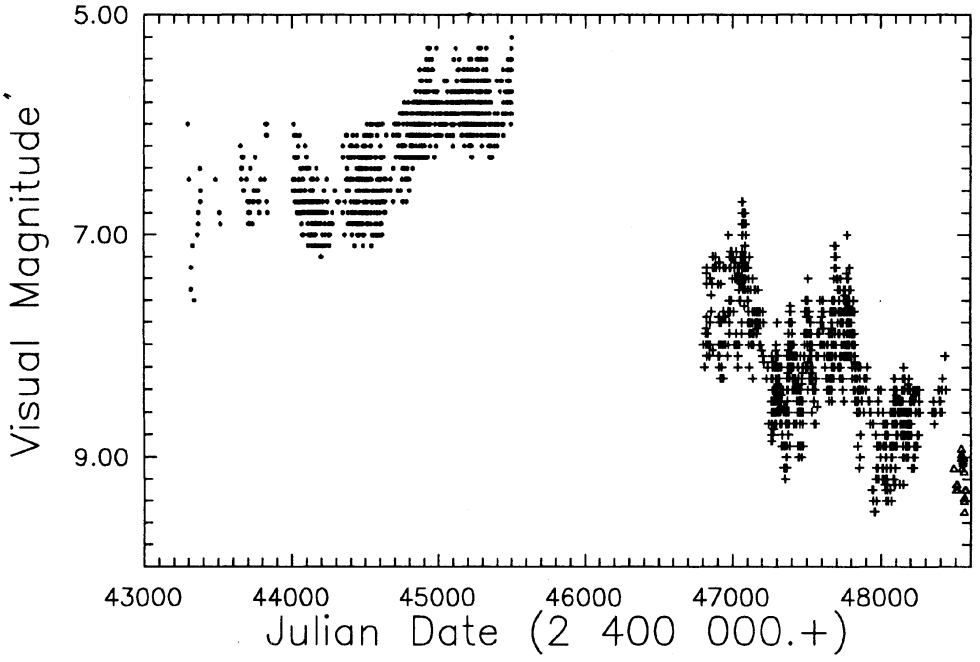

Figure 14. Visual light-curve of CH Cygni

Table 11. Photoelectric observations of CI Cygni

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
27 Aug 90	131.422	11.818	11.951	10.680	2.632	2.261	1.839^{+}	W
12 Sep 90	147.429	11.745	11.936	10.691	2.637	2.257	1.823^{+}	W
24 Sep 90	159.386	11.741	11.965	10.735	2.606	2.253	1.844^{+}	W
12 Oct 90	177.328	11.848	11.972	10.763	2.644	2.237	1.828^{+}	W
12 Apr 91	359.552	11.981	12.055	10.689	2.683	2.251	1.855^{+}	W
23 Jul 91	461.478	12.206	12.261	10.778	2.677	2.241	1.847^{+}	W
13 Aug 91	482.505	12.340	12.626	10.940	2.649	2.260	1.864^{+}	W

$+ S_2 - S_1$

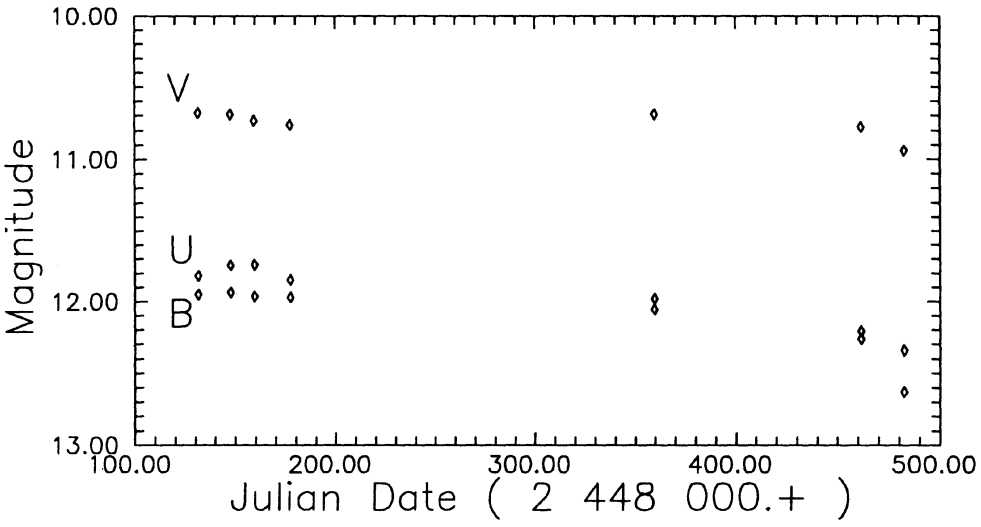

Figure 15. UBV observations of CI Cygni

3.10. V 1016 Cygni

V 1016 Cyg was measured photoelectrically on 6 nights. The stars S_1: HD 188 326, V = 7.56, B-V = 0.78, U-B = 0.35, sp. G8, S_2: SAO 48986, m_v = 9.1, m_{pg} = 10.2 and S_3: SAO 69151, m_v = 8.5, m_{pg} = 9.7 were used as standard stars. The results are compiled in Table 12.

The visual observations are shown in Fig. 17.

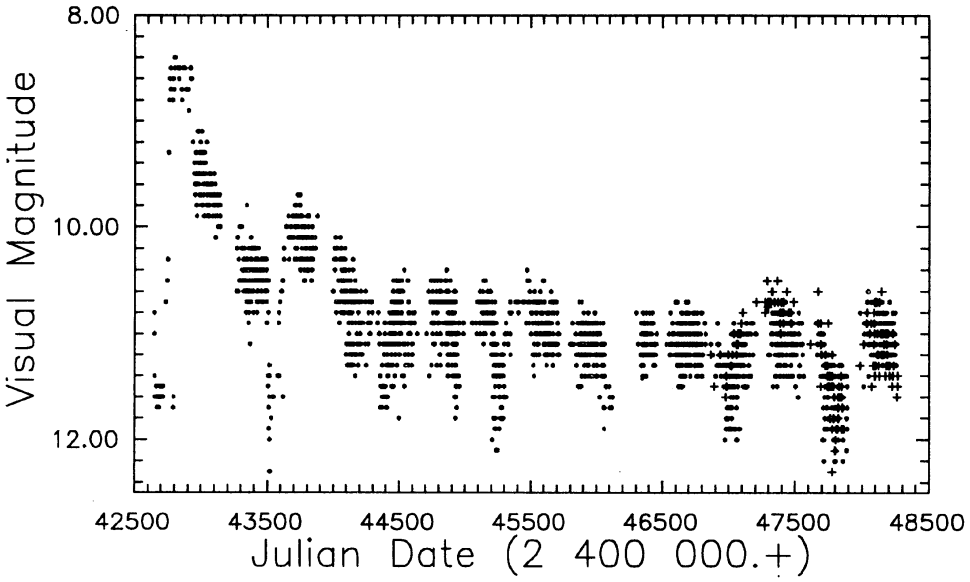

Figure 16. Visual observations of CI Cygni

Table 12. Photoelectric observations of V 1016 Cygni

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
27 Aug 90	131.459	10.831	11.458	11.253	1.991	1.406	1.081*	W
24 Sep 90	159.399	10.891	11.474	11.254	1.519	1.821	1.990+	W
					2.076	1.432	1.091*	W
12 Oct 90	177.317	10.827	11.486	11.224	1.516	1.820	2.016+	W
24 Oct 90	189.340	10.645	11.475	11.004	2.077	1.418	1.092*	SL
02 Sep 91	502.410	10.546	11.444	10.875	2.111	1.453	1.102*	SP
22 Sep 91	522.321	10.571	11.463	10.805	2.090	1.472	1.098*	SP

$+ S_2 - S_1$, $* S_3 - S_1$

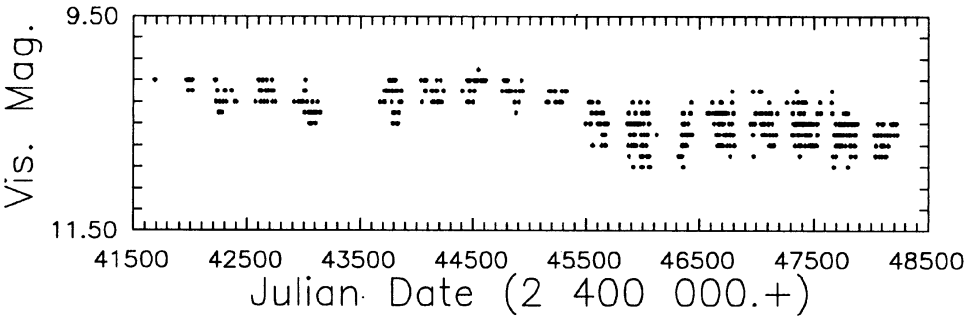

Figure 17. Visual observations of V 1016 Cygni

3.11. V 1329 Cygni

Only the photographic photometry and visual observations were collected in this part of the campaign. The results are summarized in Table 13 and shown in Fig. 18 (photographic measurements) and Fig. 19 (visual photometry).

Table 13. Photographic observations of V 1329 Cygni

Date	244...	B-mag	Date	244...	B-mag
9 Oct 82	5252.302	13.50	26 Sep 87	7065.319	13.69
25 Oct 82	5268.407	13.37	20 Jul 88	7362.501	13.55
10 Aug 83	5557.469	13.65	10 Aug 88	7384.344	13.58
11 Aug 83	5558.447	13.78	11 Aug 88	7385.396	13.48
2 Sep 83	5580.382	13.82	13 Aug 88	7387.321	13.55
6 Oct 83	5614.286	13.88	25 Jul 89	7733.327	14.68
10 Nov 85	6380.301	13.48	31 Oct 89	7831.235	14.35
7 Sep 86	6681.428	14.38	28 Jun 90	8071.420	13.63
9 Sep 86	6683.310	14.48	25 Aug 90	8129.320	13.53
2 Oct 86	6706.337	14.48	13 Mar 91	8328.628	13.45
1 Jul 87	6978.427	14.12	14 Mar 91	8329.542	13.41
24 Jul 87	7001.372	14.06	18 Apr 91	8364.504	13.48
18 Aug 87	7026.397	13.95	20 Apr 91	8366.512	13.54
27 Aug 87	7034.519	13.70	8 May 91	8385.448	13.55

These measurements were carried out at the Rozhen Observatory

3.12. AG Draconis

The photoelectric observations were obtained on 11 nights. The standard stars S_1 and S_2 are the same as used in Paper II. The results are included in Table 14 and shown in Fig. 20. As we can see the light variations are largest at shorter wavelengths: $\Delta U_{max} = 0.49$ mag, $\Delta B_{max} = 0.23$ mag and $\Delta V_{max} = 0.14$ mag during our 391 days time interval.

The visual observations are shown in Fig. 21. The most significant change in the star's brightness occurred in 1980 (discussed, e.g. by Iijima et al., 1987 in more detail). The most recent visual observations do not exhibit any variations. The smaller ones, as indicated photoelectrically, are probably below the error of visual estimations.

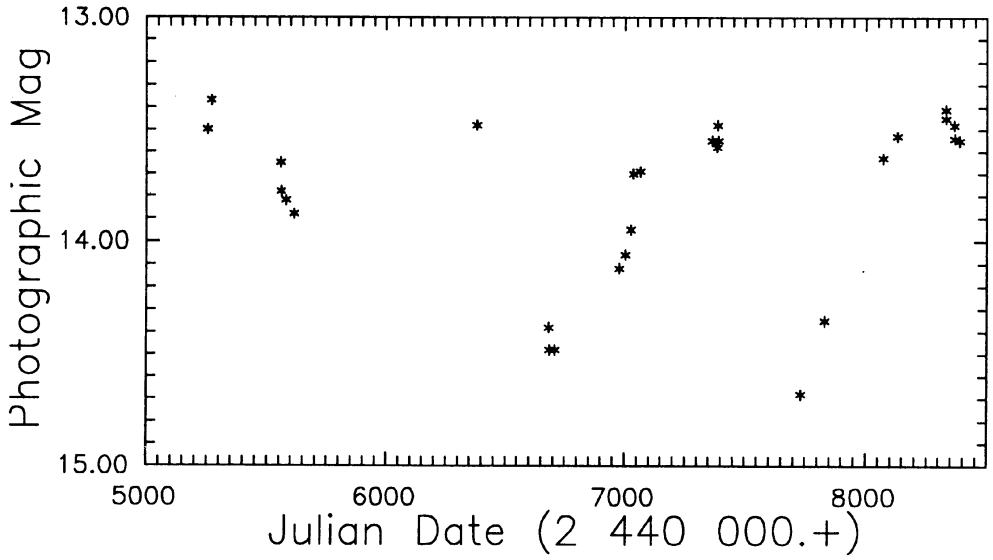

Figure 18. Photographic observations of V 1329 Cygni

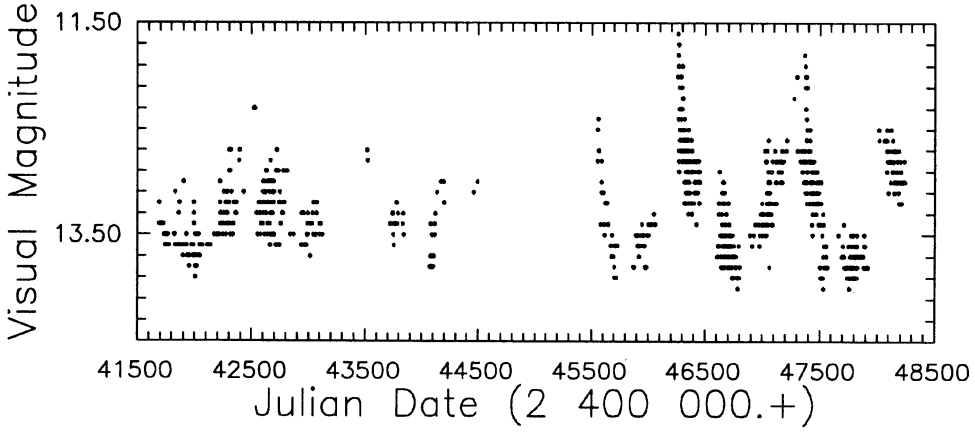

Figure 19. Visual observations of V 1329 Cygni

3.13. CQ Draconis (4 Draconis)

We have obtained a total of 51 new observational runs of 4 Dra on 49 nights between 1990 Oct 3 and 1991 Oct 29. The same comparison stars as described in Paper II were used. The results of the new observations are compiled in Table 15 (in the form of mean values in U, B and V for a particular night) and displayed in Fig. 22. As in Paper II, for the sake of completeness and clarity, the figure displays all the observations of 4 Dra we obtained by the end of this part of the campaign. Two runs of the night of 4/5 April 1991 were obtained simultaneously with the IUE and ROSAT satellites (D. Reimers, 1991, private communication).

Table 14. Photoelectric Observations of AG Draconis

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
27 Aug 90	131.377	11.906	11.168	9.804	2.267	0.450	-0.405$^+$	W
12 Sep 90	147.318	11.888	11.181	9.753	2.215	0.454	-0.448$^+$	W
3 Oct 90	168.350	11.633	11.268	9.803	2.271	0.546	-0.415$^+$	SP
12 Oct 90	177.246	11.744	11.238	9.844	2.257	0.474	-0.400$^+$	W
12 Oct 90	177.348	11.666	11.302	9.833	2.356	0.532	-0.409$^+$	SP
16 Mar 91	332.589	11.547	11.184	9.825	2.278	0.584	-0.328$^+$	W
12 Apr 91	359.467	11.418	11.073	9.738	2.321	0.496	-0.391$^+$	W
27 May 91	404.410	11.483	11.134	9.758	2.179	0.527	-0.419$^+$	W
23 Jul 91	461.434	11.622	11.098	9.740	2.228	0.539	-0.379$^+$	W
28 Aug 91	497.361	11.763	11.180	9.761	2.221	0.538	-0.375$^+$	W
4 Sep 91	504.479	11.586	11.135	9.706	2.343	0.489	-0.475$^+$	SP
22 Sep 91	522.409	11.634	11.197	9.785	2.309	0.542	-0.447$^+$	SP

$+ S_2 - S_1$

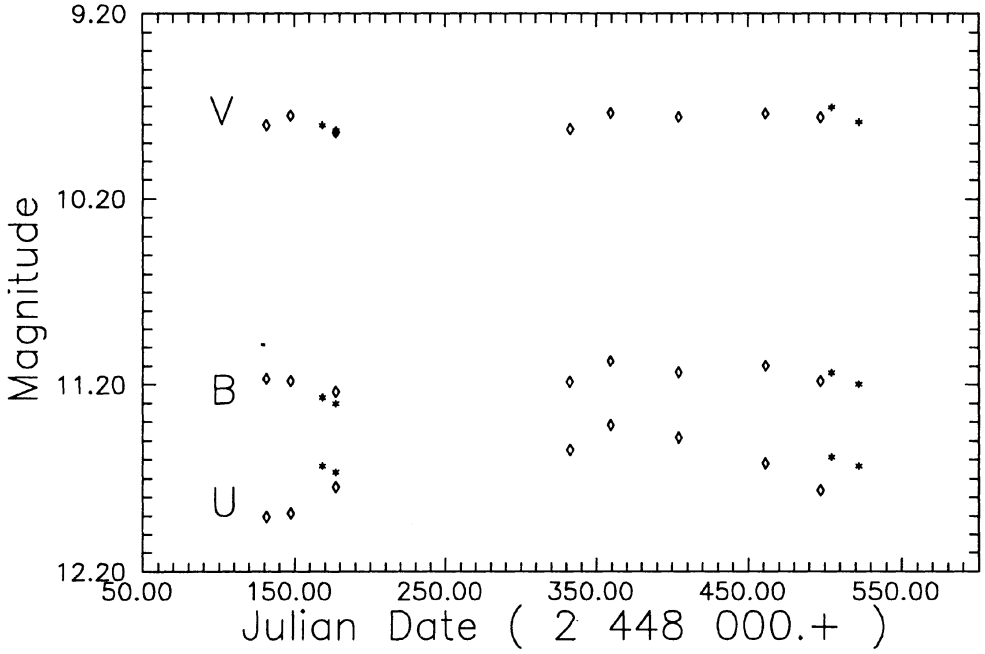

Figure 20. Photoelectric observations of AG Draconis

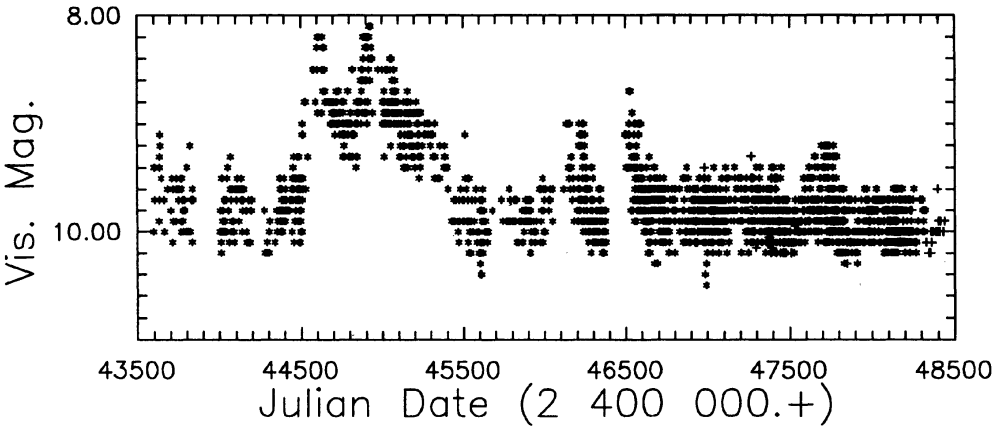

Figure 21. Visual observations of AG Draconis

The most conspicuous feature in our UBV light curves of 4 Dra is the unusual brightening with an amplitude of about 0.3 mag in U (the phenomenon is virtually undistinguishable in B and V) which took place immediately after the periastron passage within the wide 4 Dra A + BC system. The beginning of the brightening was already evident in the data presented in Paper II; this paper's data correspond mainly to the decline phase. However, the exact shape of the brightening is highly unclear due to an eclipse-like phenomenon evident in the decline phase (this feature can be distinguished even in B and V, see Fig. 22). A more detailed preliminary description and discussion but without the tabulation of the observational material presented are published elsewhere (Hric and Urban, 1991).

3.14. YY Herculis

The visual light-curve (Fig. 23) exhibits a long-term variation from $\sim$ 11.7 to $\sim$ 13.7 mag. To confirm the periodicity of this fluctuation a longer period of observations is needed.

3.15. V 443 Herculis

Photoelectric measurements of V 443 Her were carried out on 3 nights. The standard stars S_1, S_2 are the same as used in Paper II. The star S_3: SAO 85980, $m_v = 8.7$, $m_{pg} = 8.5$, sp. A0 was used as the check star. The results are compiled in Table 16.

The photographic photometry includes 24 measurements obtained on 21 nights (Table 17, Fig. 24). A minimum was observed in different spectral bands around JD 2 448 433. Unfortunately, the lack of data does not enable us to explain the nature of this minimum.

Table 15. Photoelectric Observations of 4 Draconis

Date	2448...	ΔU	ΔB	ΔV	Obs
3 Oct 90	168.289	0.929	0.312	0.051	SP
5 Oct 90	170.358	0.925	0.328	0.062	SP
9 Oct 90	174.351	0.936	0.338	0.087	SP
10 Oct 90	175.408	0.968	0.387	0.121	SP
12 Oct 90	177.287	0.973	0.388	0.128	SP
15 Oct 90	179.639	0.980	0.393	0.124	SP
15 Oct 90	180.390	0.985	0.394	0.125	SP
23 Oct 90	188.382	1.010	0.416	0.152	SP
24 Oct 90	189.310	1.002	0.417	0.150	SP
27 Oct 90	191.642	1.028	0.416	0.143	SP
13 Nov 90	209.480	1.067	0.466	0.185	SP
15 Nov 90	210.647	1.116	0.473	0.193	SP
25 Nov 90	220.628	1.084	0.458	0.181	SP
7 Dec 90	232.674	1.043	0.371	0.088	SP
29 Dec 90	254.583	1.093	0.441	0.150	SP
5 Jan 91	262.474	1.020	0.400	0.116	SL
15 Jan 91	271.568	1.034	0.340	0.057	SL
15 Jan 91	271.580	1.087	0.362	0.070	SP
16 Jan 91	272.643	1.087	0.363	0.048	SP
17 Jan 91	273.564	1.085	0.372	0.074	SP
18 Jan 91	274.551	1.075	0.373	0.078	SP
20 Jan 91	276.640	1.084	0.376	0.079	SP
22 Jan 91	278.684	1.089	0.388	0.095	SP
31 Jan 91	288.396	0.964	0.352	0.076	SL
16 Feb 91	303.674	1.025	0.352	0.065	SP
19 Feb 91	306.622	1.005	0.320	0.040	SP
27 Feb 91	315.439	1.012	0.314	0.014	SP
2 Mar 91	317.542	1.005	0.296	0.029	SP
3 Mar 91	319.480	1.013	0.337	0.044	SP
18 Mar 91	333.561	1.030	0.389	0.093	SP
3 Apr 91	350.482	0.965	0.291	0.002	SP
5 Apr 91	351.501	0.919	0.298	0.004	SP
5 Apr 91	351.601	0.950	0.296	-0.001	SP
1 Jun 91	409.451	1.090	0.446	0.192	SP
2 Jun 91	410.456	1.069	0.451	0.175	SP
5 Jun 91	413.449	1.029	0.424	0.121	SP
9 Jun 91	417.392	1.000	0.359	0.069	SP
11 Jun 91	419.396	0.987	0.337	0.043	SP
15 Jun 91	423.388	0.941	0.293	0.005	SP
18 Jun 91	426.474	0.980	0.328	0.040	SP
25 Jun 91	433.382	0.991	0.377	0.107	SP

Table 15 (continued)

Date	2448...	ΔU	ΔB	ΔV	Obs
28 Jun 91	436.384	0.935	0.427	0.156	SP
5 Jul 91	443.480	0.996	0.475	0.208	SP
23 Jul 91	461.448	1.065	0.415	0.141	SP
8 Aug 91	476.517	1.074	0.377	0.083	SP
22 Aug 91	491.401	1.120	0.479	0.208	SP
31 Aug 91	500.310	1.057	0.420	0.140	SP
3 Sep 91	503.350	0.999	0.358	0.080	SP
21 Sep 91	521.318	1.062	0.415	0.136	SP
1 Oct 91	531.492	1.015	0.367	0.074	SP
29 Oct 91	559.478	0.962	0.386	0.105	SP

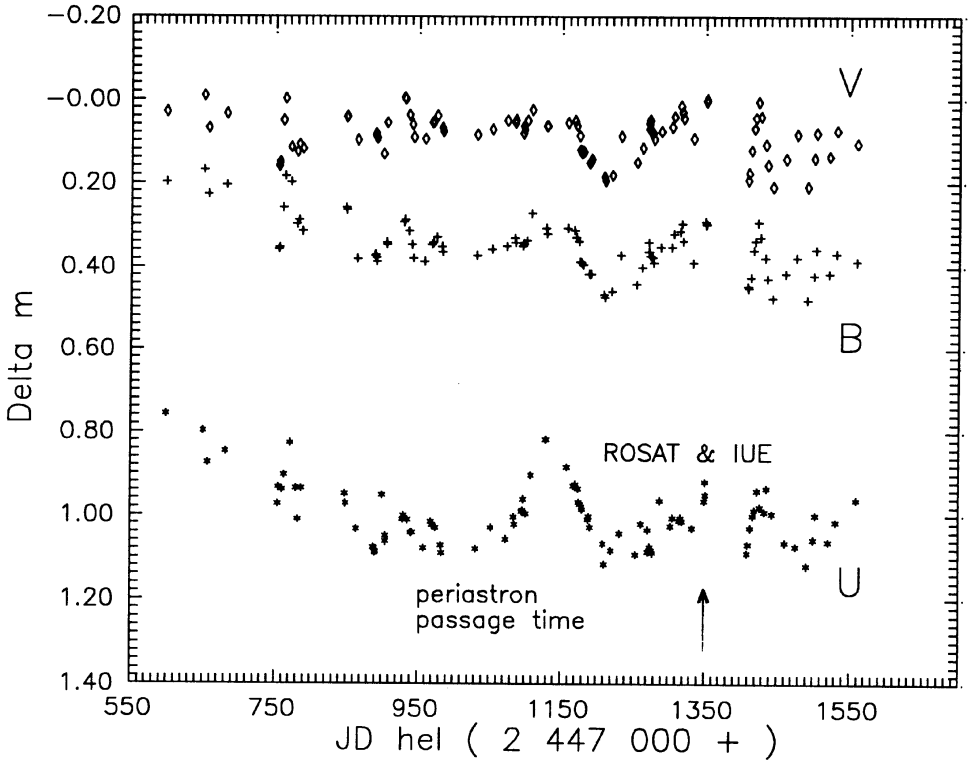

Figure 22. UBV observations of 4 Draconis. The data pointed by arrow correspond to the simultaneous observations with the ROSAT and IUE satellites

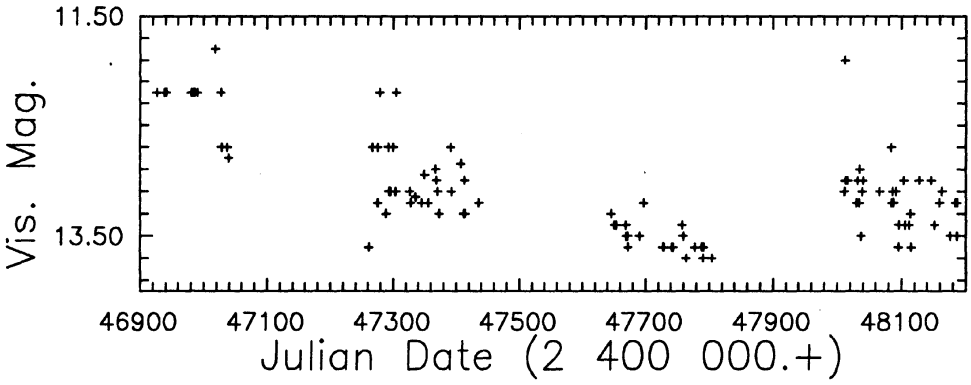

Figure 23. Visual observations of YY Herculis

The visual observations are shown in Fig. 25.

Table 16. UBV Observations of V443 Herculis

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
12 Apr 91	359.506	13.506	12.703	11.514	5.498	3.051	1.494^{+}	W
04 Sep 91	504.356	12.047	12.464	11.410	5.618	3.217	1.551^{+}	SP
					2.640	1.977	1.741^{*}	SP
22 Sep 91	522.274	11.961	12.417	11.380	5.690	3.208	1.544^{+}	SP
					2.651	1.999	1.758^{*}	SP

$+\ S_2 - S_1$, $*\ S_3 - S_1$

3.16. SS Leporis

Visual observations are shown in Fig. 26.

3.17. RS Ophiuchi

The visual light-curve is shown in Fig. 27. The variations are sudden and often strong. The most recent outburst occurred in 1985. The star's brightness reached 7.6 although its minimum corresponds to about 12 mag.

3.18. AG Pegasi

This star was observed photoelectrically on 12 nights. The stars S_1: BD+11 4681 (SAO 107460) V = 8.1, B-V = 1.05, U-B = 0.97, sp. K0, S_2: SAO 107453 $m_v = 8.1$, sp. F8 and S_3: $\alpha_{1950} = 21^h47^m48.^s5$, $\delta_{1950} = +12^o06'06''$, V = 10.360,

Table 17. The photographic observations of V 443 Herculis

Date	2 448...	mag	o	b	Date	2448...	mag	o	b
15 Oct 90	180.297	11.1	3	4*	10 Jul 91	448.414	11.7	3	6*
22 Oct 90	187.292	11.6	3	4	13 Jul 91	451.439	12.1	3	6
10 Nov 90	206.278	11.1	3	4	7 Aug 91	476.411	11.4	1	1
8 May 91	385.445	11.4	2	8	9 Aug 91	478.480	11.8	3	6
9 Jun 91	417.457	11.4	1	1*	10 Aug 91	479.349	11.2	2	8
12 Jun 91	419.483	11.8	3	6*	3 Sep 91	503.388	11.8	3	6
13 Jun 91	420.529	12.0	2	1	10 Sep 91	510.299	11.5	1	1
22 Jun 91	430.432	11.8	1	1*	10 Sep 91	510.394	11.8	3	6
5 Jul 91	443.414	11.7	1	1	3 Oct 91	533.338	12.0	3	6*
6 Jul 91	444.441	12.0	3	6*	7 Oct 91	537.243	11.6	1	1
6 Jul 91	444.460	12.0	3	6	30 Oct 91	560.229	11.4	3	3
8 Jul 91	446.358	12.0	2	8	30 Oct 91	560.248	11.6	3	1

Observers (o): 1 Komačka
2 Skalnate Pleso
3 Velič

* worse observation quality

Sp. bands: 1 (400-650) nm
3 (570-650) nm
4 (570-680) nm
6 Agfa 400+Panchr.G3
8 ORWO ZU-21

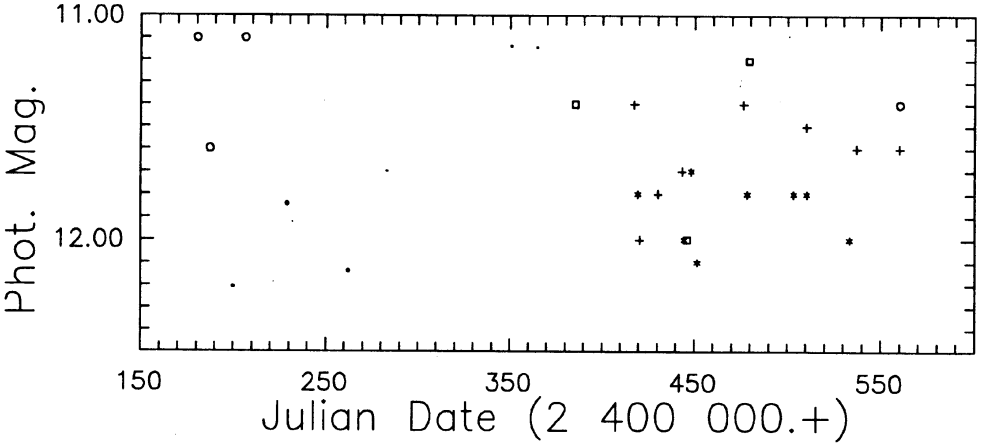

Figure 24. Photographic observations of V 443 Herculis: + observations in the spectral region 400 - 650 (680) nm, o 570 - 650 (680) nm, * Agfa 400 + Panchr. G3 filter

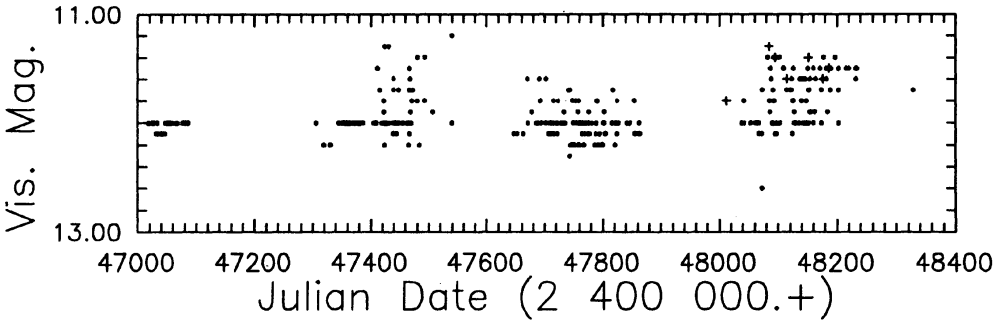

Figure 25. Visual observations of V 443 Herculis

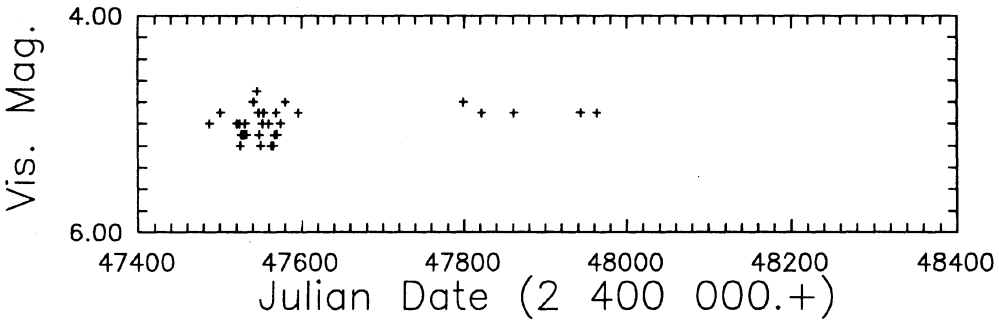

Figure 26. Visual observations of SS Leporis

B-V = 0.355, U-B = 0.213 (Paper II) were used as standard stars. The results are compiled in Table 18 and shown in Fig. 28. Between August 8, 1990 and November 9, 1990 we observed the ascending branch of the light-curve before primary minimum. In 1991 a decrease of the star's brightness was indicated.

The visual observations are shown in Fig. 29. To distinguish the minima corresponding to the orbital motion of the binary is rather difficult, but a slow gradual decrease of the star's brightness from $\sim$ 8.2 to $\sim$ 8.6 mag during our observational period can be seen.

3.19. AX Persei

The photoelectric observations of this star were obtained on 53 nights. The standard stars S_1, S_2 are the same as used in Paper II. The star near AX Per ($\alpha_{1950} = 01^h33^m.5$, $\delta_{1950} = 53^o59'.5$) was selected as the check star (S_3). The results are summarized in Table 19 and depicted in Fig. 30. The primary minimum corresponding to the total eclipse of the hot component by the cool one was observed between October 27, 1990 and January 14, 1991. The position of its center lead to the new ephemeris of the minima (Skopal, 1991):

$$JD(Min) = 2\ 436\ 673.3(\pm 0.6) + 679.9(\pm 1.2)E$$

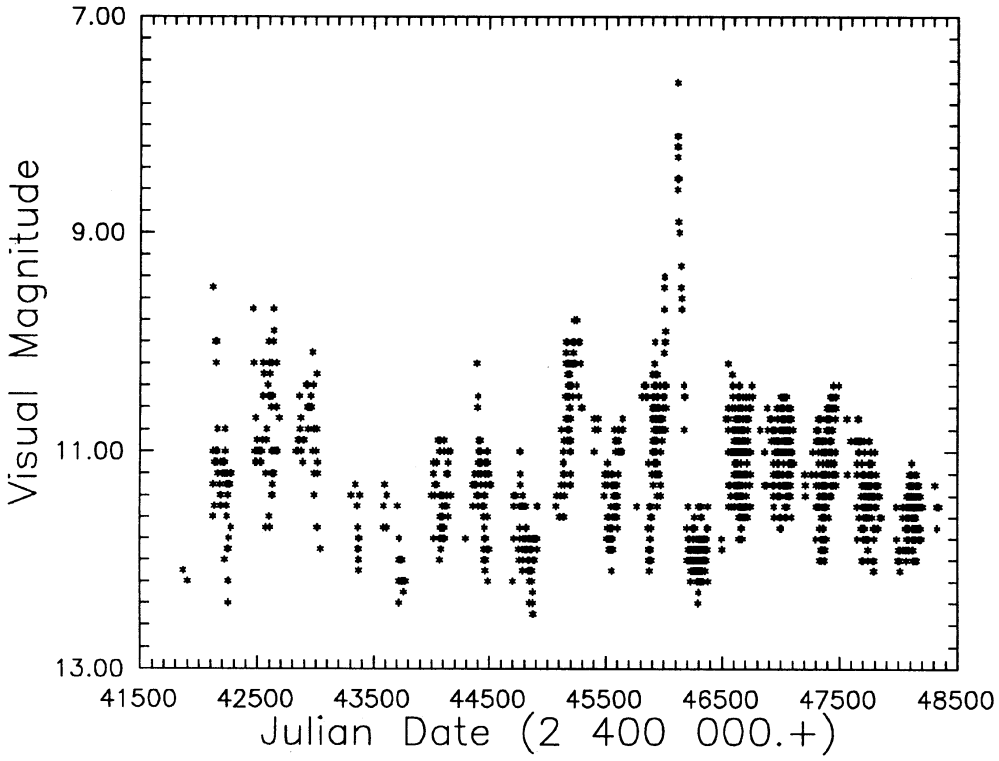

Figure 27. Visual observations of RS Ophiuchi

Table 18. Photoelectric Observations of AG Pegasi

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
08 Aug 90	112.559	9.944	9.893	8.669	0.709	1.585	2.284*	W
27 Aug 90	131.436	9.994	9.956	8.713	0.859	1.566	2.211*	W
12 Sep 90	147.388	9.922	9.855	8.555	0.812	1.556	2.184*	W
24 Sep 90	159.432	9.972	9.904	8.630	0.869	1.611	2.242*	W
12 Oct 90	177.291	9.865	9.918	8.656	0.787	1.569	2.209*	W
16 Oct 90	181.380			8.583				B1
09 Nov 90	205.249			8.516				B1
23 Jul 91	461.535	9.348	9.638	8.443	0.801	-0.010	-0.552$^+$	W
30 Jul 91	468.502	9.489	9.679	8.454	0.696	-0.004	-0.565$^+$	W
13 Aug 91	482.530	9.438	9.708	8.518	0.776	-0.002	-0.550$^+$	W
03 Sep 91	503.407	9.275	9.738	8.504	0.847	1.500	2.164*	SP
22 Sep 91	522.368	9.407	9.795	8.652	0.765	1.448	2.116*	SP

$+\ S_1 - S_2$, $*\ S_1 - S_3$

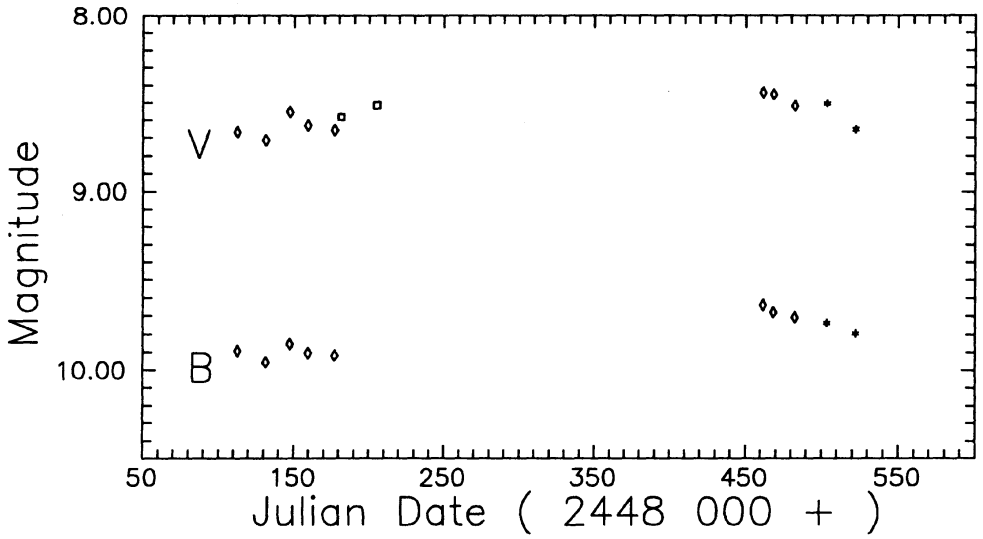

Figure 28. B and V observations of AG Pegasi

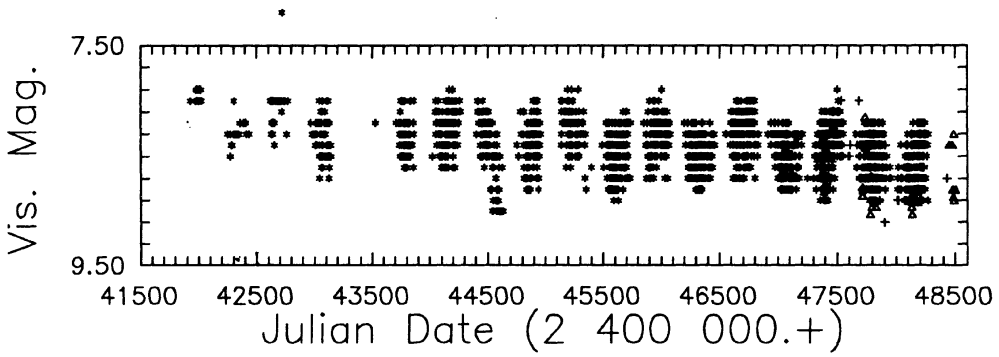

Figure 29. Visual observations of AG Pegasi

In March, 1991 the active phase of AX Per was over. A post-activity phase was observed during summer and autumn 1991.

The visual observations are shown in Fig. 31.

3.20. HM Sagittae

Visual observations are shown in Fig. 32. The observed variations ($\Delta m_v \sim$ 1.2 mag) evidently exceed the errors of the visual magnitude estimations. They probably reflect real changes. But it is difficult to speculate about the periodicity in this light-curve, because seasonal gaps regularly interrupt its continuity. This star can be recommended for photoelectric observations, too.

Table 19. Photoelectric observations of AX Persei

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
08 Aug 90	112.524	10.680	11.027	10.249	1.744	0.737	0.054+	W
27 Aug 90	131.507	10.855	11.154	10.369	1.792	0.789	0.092+	W
29 Aug 90	133.573	10.820	11.139	10.334	1.765	0.675	0.029+	W
18 Sep 90	152.527	10.977	11.405	10.546	1.759	0.804	0.011+	SP
24 Sep 90	159.482	11.102	11.448	10.687	1.737	0.750	0.061+	W
03 Oct 90	167.554	11.099	11.605	10.717	1.764	0.802	0.020+	SP
04 Oct 90	168.510	11.168	11.605	10.738	1.777	0.813	0.031+	SP
11 Oct 90	175.564	11.179	11.615	10.788	1.777	0.808	0.025+	SP
12 Oct 90	177.404	11.277	11.608	10.857	1.781	0.761	0.081+	W
13 Oct 90	177.532	11.203	11.624	10.799	1.780	0.810	0.036+	SP
15 Oct 90	179.536	11.225	11.638	10.817	1.769	0.807	0.033+	SP
16 Oct 90	180.602	11.289	11.626	10.850	1.793	0.758	0.069+	W
17 Oct 90	181.508	11.290	11.679	10.860	1.779	0.811	0.033+	SP
22 Oct 90	187.623	11.412	11.728	10.968	1.770	0.761	0.074+	W
26 Oct 90	190.502	11.494	11.839	11.035	1.778	0.816	0.040+	SP
26 Oct 90	191.423	11.612	11.967	11.160				SL
27 Oct 90	191.538	11.537	11.869	11.105	2.988	2.428	2.060*	SP
10 Nov 90	206.403	12.436	12.928	11.961				SL
10 Nov 90	206.438	12.325	12.814	11.832	3.004	2.431	2.047*	SP
15 Nov 90	210.506	12.527	13.002	12.019	3.015	2.407	2.022*	SP
02 Dec 90	228.442	12.572	13.071	12.086				SP
06 Dec 90	232.469	12.599	13.047	12.149	2.998	2.403	2.073*	SP
08 Dec 90	234.327	12.601	13.001	12.035	3.047	2.422	2.032*	SP
11 Dec 90	237.190	12.822	13.122	12.048				SL
13 Dec 90	239.479	12.621	13.011	11.975	3.034	2.419	2.068*	SP
14 Dec 90	240.467	12.620	12.984	12.009	3.026	2.417	2.077*	SP
20 Dec 90	246.392	12.666	13.049	12.001	3.014	2.421	2.042*	SP
28 Dec 90	254.204	12.581	12.877	11.891				SL
28 Dec 90	254.269	12.523	12.945	11.744	1.853	0.797	0.050+	W
28 Dec 90	254.359	12.420	12.742	11.830	3.024	2.413	2.082*	SP
05 Jan 91	262.417	12.257	12.588	11.680				SL
14 Jan 91	271.208	11.737	11.976	11.112				SL
15 Jan 91	272.228	11.679	11.925	11.069				SL
15 Jan 91	272.318	11.674	11.897	11.025	2.994	2.430	2.050*	SP
17 Jan 91	274.208	11.677	11.913	11.051				SL
18 Jan 91	275.309	11.682	11.938	11.049				SL
19 Jan 91	276.333	11.659	11.918	11.026				SL
21 Jan 91	278.272	11.615	11.857	10.988				SL
22 Jan 91	279.214	11.577	11.849	10.970				SL
23 Jan 91	280.451	11.617	11.909	10.992	3.008	2.404	2.060*	SP

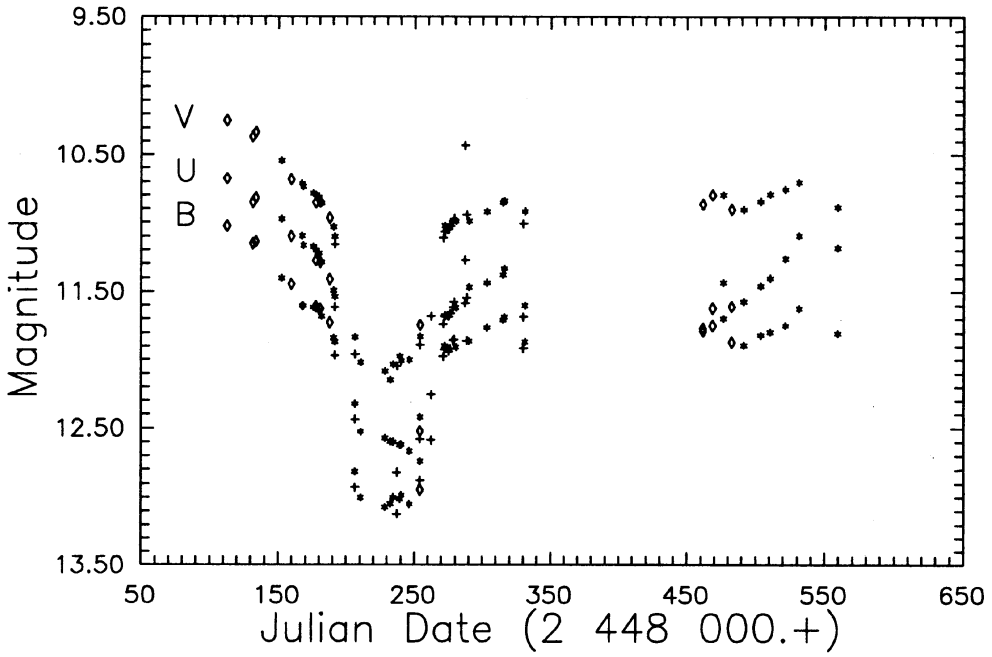

Figure 30. UBV photoelectric observations of AX Persei

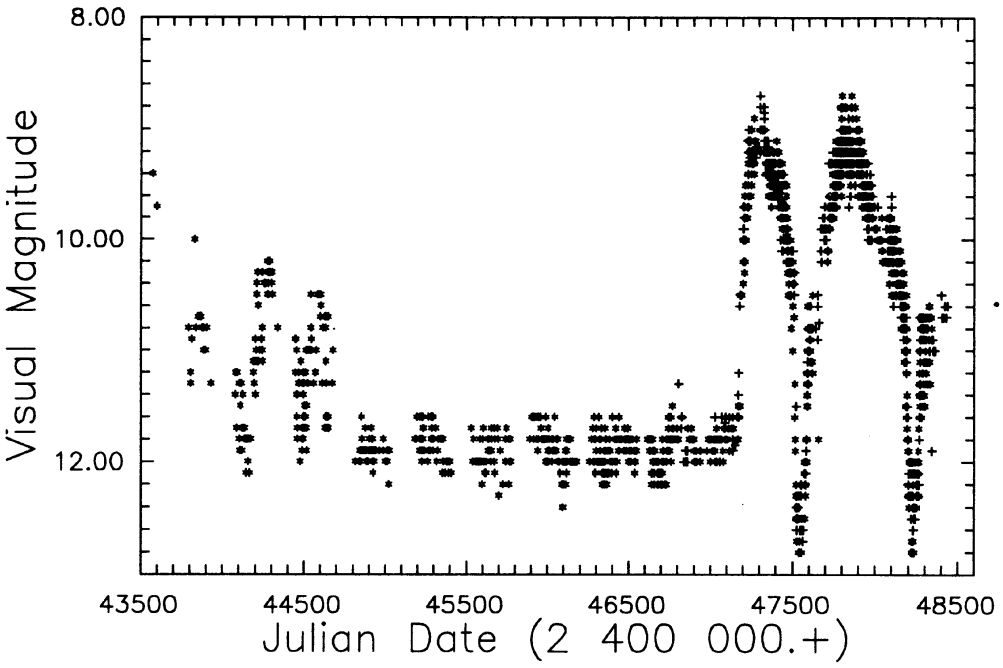

Figure 31. Visual observations of AX Persei

Table 19 (continued)

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
30 Jan 91	287.322	11.272	11.583	10.432				SL
31 Jan 91	288.300	11.544	11.860	10.943				SL
02 Feb 91	290.284	11.469	11.863	10.989	2.957	2.413	2.082*	SP
15 Feb 91	303.260	11.436	11.762	10.921	2.964	2.398	2.068*	SP
27 Feb 91	315.255	11.380	11.707	10.854	3.011	2.430	2.066*	SP
28 Feb 91	316.264	11.334	11.686	10.843	3.007	2.413	2.064*	SP
14 Mar 91	330.262	11.685	11.917	11.009				SL
15 Mar 91	331.294	11.602	11.866	10.919	3.002	2.412	2.060*	SP
23 Jul 91	461.546	11.768	11.787	10.866	1.772	0.761	0.063+	W
30 Jul 91	468.538	11.619	11.748	10.798	1.760	0.754	0.056+	W
08 Aug 91	476.574	11.433	11.697	10.797	2.833	2.373	2.054*	SP
13 Aug 91	482.541	11.608	11.871	10.903	1.828	0.809	0.092+	W
22 Aug 91	491.463	11.571	11.893	10.904	3.030	2.403	2.052*	SP
04 Sep 91	503.508	11.460	11.817	10.846	2.904	2.388	2.034*	SP
11 Sep 91	510.506	11.402	11.793	10.792	2.959	2.442	2.110*	SP
22 Sep 91	521.532	11.260	11.746	10.757	2.977	2.407	2.041*	SP
01 Oct 91	531.425	11.094	11.622	10.704	2.997	2.420	2.063*	SP
29 Oct 91	559.430	11.181	11.803	10.888	3.014	2.409	2.078*	SP

$+ S_2 - S_1$, $* S_3 - S_2$

3.21. FG Serpentis

Visual observations of this star are shown in Fig. 33. Light variations from $\sim$ 10 to $\sim$ 12 mag were observed. The sudden decrease (to $\sim$12.5 mag) around JD 2 447 830 is interesting. Around JD 2 447 850, FG Ser was not seen by BAA observers (see Paper II). This fact independently confirms the decrease in the star's brightness.

3.22. PU Vulpeculae

The photoelectric observations of PU Vul were made on 45 nights. The list of standard stars was presented in Paper II. The results are compiled in Table 20 and shown in Fig. 34. During our observational period, the brightness of PU Vul was practically constant in the U near 10.5 mag, in the B around 11.2 mag with a very small decrease, and in the V with a decrease from 10.7 mag to 11.1 mag.

The visual observations are shown in Fig. 35.

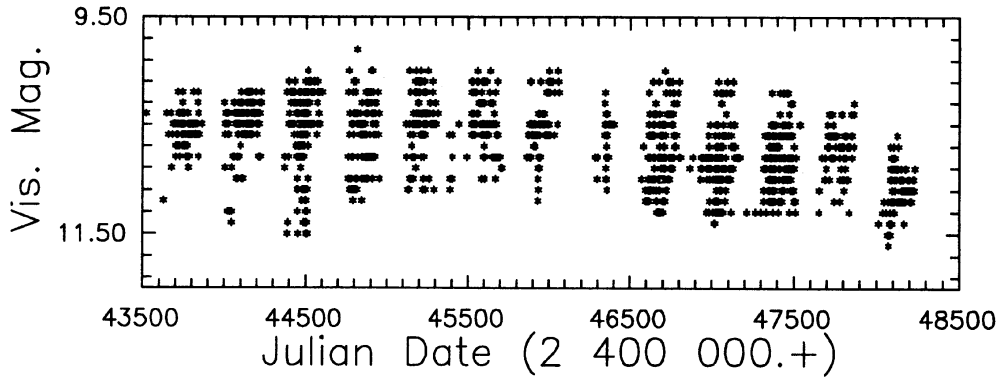

Figure 32. Visual observations of HM Sagittae

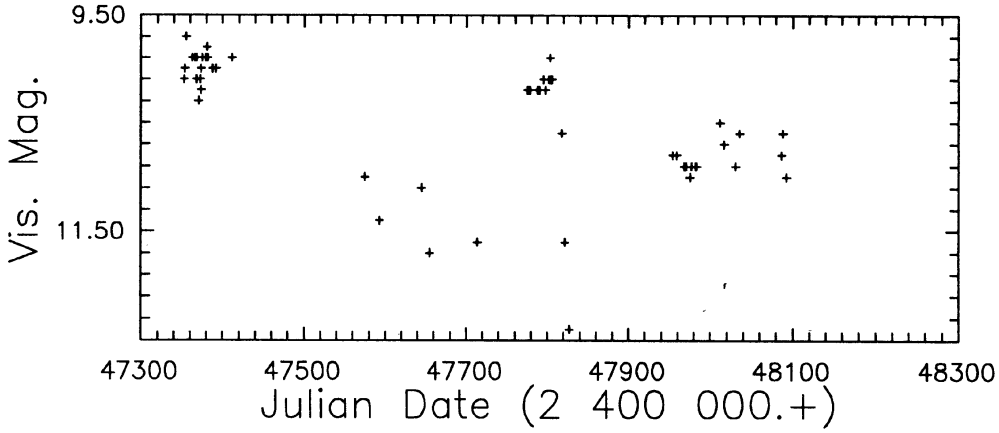

Figure 33. Visual observations of FG Serpentis

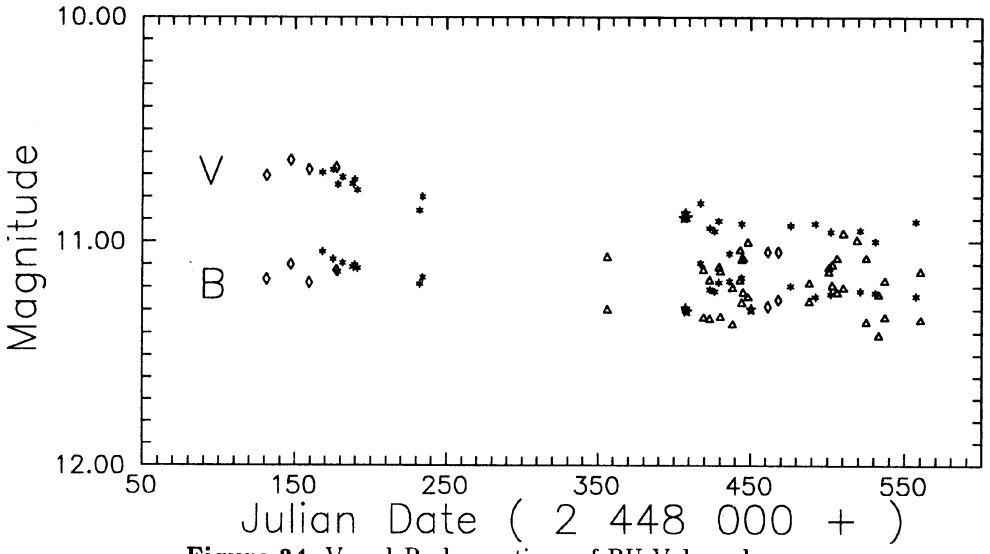

Figure 34. V and B observations of PU Vulpeculae

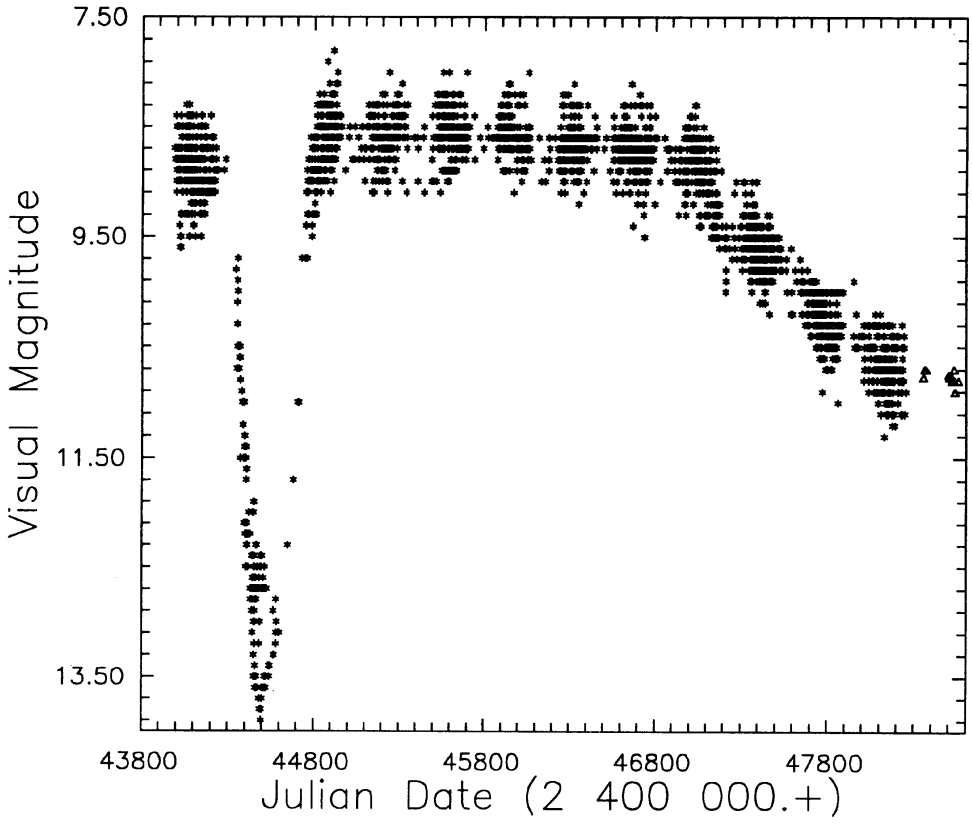

Figure 35. Visual observations of PU Vulpeculae

Table 20. Photoelectric Observations of PU Vulpeculae

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
27 Aug 90	131.407	10.634	11.165	10.708	3.705	1.348	-0.311^{+}	W
					1.614	-0.311	-1.355*	W
12 Sep 90	147.399	10.513	11.101	10.638	3.611	1.334	-0.286^{+}	W
					1.579	-0.324	-1.310*	W
24 Sep 90	159.416	10.676	11.180	10.679	3.692	1.343	-0.290^{+}	W
					1.596	-0.306	-1.332*	W
03 Oct 90	168.256	10.378	11.045	10.693	1.712	-0.239	-1.377*	SP
10 Oct 90	175.351	10.351	11.078	10.681	1.753	-0.274	-1.382*	SP
12 Oct 90	177.261	10.608	11.128	10.672	3.678	1.338	-0.316^{+}	W
					1.607	-0.314	-1.363*	W
13 Oct 90	178.330	10.353	11.135	10.747				SP
16 Oct 90	181.234	10.372	11.095	10.714	1.807	-0.240	-1.389*	SP
23 Oct 90	188.222	10.373	11.114	10.744	1.790	-0.241	-1.369*	SP
24 Oct 90	189.229	10.347	11.104	10.725	1.788	-0.221	-1.348*	SP
26 Oct 90	191.221	10.365	11.118	10.771	1.821	-0.237	-1.372*	SP
06 Dec 90	232.252	10.423	11.187	10.863	1.711	-0.286	-1.377*	SP
08 Dec 90	234.277	10.414	11.158	10.801	1.718	-0.269	-1.349*	SP
09 Apr 91	356.360		11.296	11.066				B2
29 May 91	406.583			10.893				K
30 May 91	407.569		11.291	10.872				K
31 May 91	408.565		11.303	10.891				K
10 Jun 91	417.529	10.396	11.096	10.828	1.692	-0.217	-1.402*	SP
11 Jun 91	419.544		11.330	11.120				B2
16 Jun 91	423.506	10.417	11.209	10.939	1.817	-0.245	-1.366*	SP
16 Jun 91	423.540	10.601	11.335	11.165				B2
19 Jun 91	426.526	10.425	11.218	10.952	1.729	-0.272	-1.387*	SP
22 Jun 91	429.501	10.434	11.178	10.907	1.785	-0.243	-1.356*	SP
22 Jun 91	429.540			11.108				B2
23 Jun 91	430.540	10.558	11.327	11.127				B2
29 Jun 91	436.512	10.488	11.173	11.053	1.713	-0.227	-1.359*	SP

Table 20 (continued)

Date	2448...	U	B	V	ΔU	ΔB	ΔV	Obs
02 Jul 91	438.530	10.460	11.360	11.200				B2
06 Jul 91	443.520	10.425	11.165	11.035				B2
07 Jul 91	444.520	10.364	11.159	10.921	1.751	-0.251	-1.381*	SP
07 Jul 91	444.540	10.385	11.265	11.075				B2
08 Jul 91	445.520	10.400	11.220	11.070				B2
11 Jul 91	448.530	10.460	11.240	11.000				B2
13 Jul 91	450.591			11.295				K
23 Jul 91	461.493	10.670	11.283	11.044	3.721	1.366	-0.338+	W
					1.596	-0.311	-1.386*	W
30 Jul 91	468.484	10.633	11.255	11.046	3.741	1.377	-0.368+	W
					1.579	-0.324	-1.423*	W
07 Aug 91	476.394	10.373	11.194	10.927	1.777	-0.286	-1.412*	SP
19 Aug 91	488.440	10.440	11.260	11.180				B2
23 Aug 91	492.424	10.580	11.241	10.920	1.611	-0.292	-1.375*	SP
01 Sep 91	501.400	10.424	11.130	11.110				B2
02 Sep 91	502.313	10.419	11.229	10.955	1.776	-0.265	-1.377*	SP
03 Sep 91	503.410	10.428	11.190	11.100				B2
06 Sep 91	506.410	10.400	11.220	11.070				B2
10 Sep 91	510.350	10.408	11.200	10.960				B2
19 Sep 91	519.400			10.990				B2
21 Sep 91	521.428	10.507	11.217	10.950	4.021	1.447	-0.340+	SP
					-1.907	0.239	1.362*	SP
25 Sep 91	525.330	10.470	11.350	11.070				B2
01 Oct 91	531.376	10.417	11.224	10.999	1.854	-0.236	-1.335*	SP
03 Oct 91	533.300	10.650	11.410	11.230				B2
07 Oct 91	537.310	10.550	11.330	11.170				B2
27 Oct 91	557.350	10.701	11.239	10.911	3.915	1.466	-0.294+	SP
					1.705	-0.243	-1.349*	SP
30 Oct 91	560.260	10.573	11.343	11.130				B2

+ $S_1 - S_2$, * $S_1 - S_3$

Acknowledgements. The coordinators of the campaign (L.H., A.S., Z.U.) wish to express their special thanks to the other co-authors of the present paper for making available their observational material. We gratefully acknowledge the very precise systematic observations of the symbiotic stars by the members of the French Association of Variable Star Observers, Berliner Arbeitsgemenschaft für Veränderliche Sterne, and by the individual observers from Czechoslovakia (J. Krtička, T. Nejezchleba and V. Šimon). We are also indebted to Z. Komárek for providing us with his photographic observations. This work was supported by Slovak Academy of Sci. Grant No. 495/92.

Note: 1. Magnitude differences of the standard stars for UV Aur published in Paper II (page 309, Table 3) are not correct.
2. The standard star S_3 (HD 182 691), V=6.50, B-V=-0.08, U-B=-0.36 for the CH Cyg observation was used at the Wroclaw Observatory. The published values in Paper II (page 315, Table 9, lines marked by W) should be corrected by the value of 0.025 for V, 0.002 for B-V and 0.120 for U-B, because the values V=6.525, B-V=-0.078, U-B=-0.240 for S_3 (Acta Astron. **40**, 129) were presented as used.

References

Hric, L., Skopal, A.: 1989, *Inf. Bull. Variable Stars* , No. 3364
Hric, L., Urban, Z.: 1991, *Inf. Bull. Variable Stars* , No. 3683
Hric, L., Skopal, A., Urban, Z., Dapergolas, A., Hanžl, D., Isles, J.E., Niarchos, P., Papoušek, J., Pigulski, A., Velič, Z.: 1991, *Contrib. Astron. Obs. Skalnaté Pleso* **21**, 303 - Paper II
Iijima, T., Vittone, A., Chochol, D.: 1987, *Astron. Astrophys.* **178**, 203
Johnson, H.M.: 1986, *Astrophys. J.* **300**, 401
Kenyon, S.J.: 1986, *The symbiotic stars*, Cambridge University Press, Cambridge
Kenyon, S.J., Webbink, R.F.: 1984, *Astrophys. J.* **279**, 252
Pucinskas, A.: 1970,*Bull. Vilnius Univ. Astron. Obs.* No. 27, 24.
Skopal, A.: 1991, *Inf. Bull. Variable Stars* , No. 3603.
Skopal, A., Hric L., Urban, Z.: 1990, *Contrib. Astron. Obs. Skalnaté Pleso* **19**, 123 - Paper I
Skopal, A., Chochol, D., Vittone, A., Blanco, C., Mammano, A.: 1991, *Astron. Astrophys.* **245**, 531
Willson, L.A., Garnavich, P., Mattei, J.A.: 1981, *Inf. Bull. Variable Stars* , No. 1961