

PHOTOELECTRIC MONITORING OF BRIGHT Be STARS

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ABSTRACT

We describe and summarize our *BV* photometric observations of 34 bright, active Be stars made at various times between 1981 and 1987 with a 0.4-m telescope at the University of Toronto. These observations demonstrate the photometric variability of Be stars on time scales of hours to years. Observers who wish to compare or combine these observations with other data on these stars may obtain them from the IAU Archives of Unpublished Photoelectric Observations of Variable Stars.

Key words: variable stars—B emission-line stars—photometry

I. Introduction

The Be stars are hot stars (10,000 K to 30,000 K) which have shown emission in at least one Balmer line on at least one occasion. The emission lines arise from hot gas in a ring, shell, or cloud around the star. As the definition suggests, the Be phenomenon can come and go, and the Be stars are variable on a variety of time scales. They are perhaps the most complex of all the hot stars, and a satisfactory explanation for their emission and their many kinds of variability has not yet been found. All aspects of these stars are reviewed in the recent conference proceedings edited by Slettebak and Snow (1987).

The long-term (weeks to decades) spectroscopic and photometric variability of Be stars seems to reflect the variable amount of gas around them. According to the “standard” picture of a Be star—in which the star is surrounded by a slowly-expanding equatorial disk of cool gas—the details of the variability depend on the inclination of the rotation axis of the star to the line of sight. Stars which are viewed equator-on tend to show “shell” spectra with narrow absorption lines. These are accompanied by a slight decrease in the brightness of the star. Pole-on stars tend to show emission lines which are accompanied by a slight increase in the brightness of the star, at least in some wavelength bands.

The short-term (hours to a day or two) variability takes the form of variability in the stellar-absorption-line profiles and small variability in the brightness and color. This has been successfully modeled by nonradial pulsation (Baade 1987; Percy 1987), though other observers have proposed that it is due to rotational phenomena involving spots or circumstellar material associated with possible magnetic fields in the star.

In a few Be stars there is spectroscopic and photometric variability on a time scale of days or weeks, associated

with the effects of mass transfer in an interacting binary system. CX Draconis, discussed below, is one example.

Some years ago Harmanec, Horn, and Koubský (Ondřejov Observatory) proposed (Harmanec 1980; Harmanec *et al.* 1980*a,b*) that a cooperative campaign should be organized to gather systematic, long-term (10 to 20 years) *UBV* photometry of all Be stars brighter than $V \sim +6.5$. The purpose was to provide information about the variability of a large, unbiased sample of objects, on time scales from hours to decades. The need to combine observations from many sources made it absolutely essential to establish standard procedures for obtaining, reducing, and transforming the data. Each program star was part of a group containing one or more variables, a comparison, check, and red standard star. The primary comparison star was used so that accurate differential photometry could be done. The check star was used to confirm the constancy of the comparison star as well as to monitor the general quality of the data. The red standard was used to check the quality of the transformation from the instrumental to the standard *UBV* system. Each participant in the campaign was required to use these sets of standard comparison stars and to reduce and transform the data using appropriate and well-documented procedures. Several observatories are presently contributing to this campaign.

This campaign was found to be an ideal summer program for the 0.4-m reflecting telescope on the downtown campus of the University of Toronto. The telescope is used for teaching purposes for most of the year but is available for research from early May to late August. From 15 to 30 photometric nights can be expected during these months. The sky brightness limits photometry to stars brighter than about magnitude 8 or 9; the bright Be stars have magnitudes of 7 or brighter. The observations have been made by undergraduate research assistants,

supported by the Summer Undergraduate Research Awards program of the Natural Sciences and Engineering Research Council of Canada.

The purpose of this paper is to describe and summarize our observations and to announce their availability to others who might wish to make use of them.

II. Observations

The observations were made using a Boller and Chivens 0.4-m reflector mounted on the 16th floor of the McLennan Physical Laboratories. It is equipped with a dc photometer, utilizing an EMI6094 photomultiplier operated at ambient temperature, dc amplifier, voltage-to-frequency converter, and digital counter.

Observations were corrected for extinction using seasonal extinction coefficients of $k_p = 0.25$ and $k_b = 0.40$. The use of seasonal coefficients was found to give more reliable results than nightly coefficients. Transformation coefficients were determined at least twice each season, using blue-red star pairs and also using the system of blue and red standards in the Be star campaign. All of the standard comparison stars were used in almost every case. Due to the limitations of the dc photometric system, a few particularly bright or faint red standards could not be used.

The light curve of a typical nonvariable check star is shown in Figure 7. In this and other stars, the precision of a single observation is about $0^m.007$.

The program stars were chosen in consultation with Petr Harmanec of the Ondřejov Observatory. They were generally bright, well-placed, active Be stars—often stars known or suspected to be variable on a short time scale. In this case observations of the stars were generally made two or more times each night. In many cases the same stars were being observed by Harmanec or other observers at locations outside North America. The 1987 observations of α Andromedae and KY Andromedae were made as part of a multiwavelength, multisite “campaign” organized by G. J. Peters.

Table I lists the program and comparison stars and their properties.

III. Results

The results of our observations are summarized in Table II and are discussed below on a star-by-star basis. A few representative light curves are shown. The observations have been deposited in File Number 176 of the IAU Archive of Unpublished Photoelectric Observations (Breger 1985) and may be obtained from that archive or from J. R. Percy. Observations of P Cygni (Percy *et al.* 1988) and of the variable comparison star 27 Cygni (Percy *et al.* 1986) have already been published. With the exception of 27 Cyg, we have not discovered any other significantly-variable comparison stars.

κ Draconis: This star is not a Be star but a normal A star

originally used as a comparison star for κ Draconis but subsequently found to be variable.

ν^2 Bootis: Slightly variable on time scales of days or more. In 1981 HR 5733 and HR 5727 were used as comparison stars for this star and for θ Coronae Borealis.

θ Coronae Borealis: In 1981 and 1985 the variation was insignificant, but in 1986 and 1987 (Fig. 1) there were variations on time scales of days. The large short-term variations reported by Roark (1971) have not been confirmed nor has the suggestion (Harmanec 1983) that this star might be a 510-day eclipsing binary.

4 Herculis: This 46.19432-day spectroscopic binary (Heard *et al.* 1975) showed only marginal variations, though our observations are rather sparse.

88 Herculis: This 86.7-day spectroscopic binary (Harmanec *et al.* 1972) showed only slight variations on time scales of days to months (Fig. 1). Long-term variations were discovered by Harmanec *et al.* (1978) and were further described by Doazan and her colleagues (see Doazan, Thomas, and Barylak (1986) for references to earlier work).

66 Ophiuchi: This star showed small variations, on time scales as short as a few hours, during each season (Fig. 2). This star shows remarkable variations in its mass loss properties, as deduced from ultraviolet and visual spectroscopic observations (Grady *et al.* 1987; Peters 1988).

MWC 601: An “active” star, which showed variations of up to $0^m.1$ on time scales of hours to years (Fig. 2).

CX Dra: This star is an interacting binary with a period of 6.69603 days. Phase-related brightness variations of $0^m.04$ and long-term variations of $0^m.2$ have been reported by Koubský *et al.* (1980). Our observations (Fig. 2) show similar variations, though we have not investigated the phase-related variations in detail. For the long-term variations, $\Delta(B - V) \sim -0.3 \Delta V$.

V923 Aquilae: Short-term variations with a period of 0.8518 day and an amplitude of up to $0^m.1$ were reported by Lynds (1960). Our observations show small variations on several time scales (Fig. 3), with a noticeable fading at about JD2444810. This star shows variations in radial velocity and V/R ratio on a time scale of about six years and is suspected to be a spectroscopic binary with a period of 214.75 days (Koubský *et al.* 1988).

V1294 Aquilae: This star also showed variations on a variety of time scales. In the summer of 1982 it faded by about $0^m.1$ in V with little change in $(B - V)$. It also faded by about $0^m.05$ in V around JD24446660 (Fig. 3). Horn *et al.* (1982) have described the light variations in this star.

2 Vulpeculae: According to Lynds (1959) this star shows short-term variations with a range of $0^m.06$, a period of 0.6096 day, and a light curve with double minima. Other observers have reported short-term variations also. Our observations also showed small but significant variability on a time scale of a day or more.

TABLE I

Program and Comparison Stars
Column S gives the status of each star: program,
comparison, check, or red standard.

Star	S	HR	HD	Sp. Type	V	B-V
8 Dra	V	4916	112429	A5	5.2	
	CO	4687	107193	A2	5.488	+0.034
2						
v Boo	V1	5774	138629	A3	5.0	
θ CrB	V2	5778	138749	B7e	4.2	
4 Her	V3	5938	142926	B7Ve	5.8	
υ Her	CO	5982	144206	B9p	4.76	-0.11
	CH	5760	138341	A4IV	6.46	+0.19
50 Boo	CH	5718	136849	B9Vn	5.37	-0.07
λ CrB	RS	5936	142908	F2	5.45	+0.33
88 Her	V	6664	162732	B6IVe	6.7	
	CO	6641	162132	A0	6.493	+0.07
77 Her	CH	6509	158414	A4	5.847	+0.121
66 Oph	V	6712	164284	B2Ve	4.8	
	CO	6719	164432	B3III	6.33	-0.08
	CH	6690	163641	A0	6.26*	+0.00
MWC 601	V	6873	168797	Be	6.1	
	CO	6928	170200	B8	5.72	-0.03
	CH	6900	169578	B9	6.74	+0.02
	RS	6925	170137	K3III	6.07	+1.62
CX Dra	V	7084	174237	B5e	5.9	
	CO	7060	173664	A2	6.187	+0.080
	CH	7028	172883	B9	5.994	-0.069
	RS	7123	175225	G8	5.50	+0.84
V 923 Aql	V1	7415	183656	B6e	6.1	
V1294 Aql	V2	----	184279	B0e	6.8	
35 Aql	CO	7400	183324	A0	5.80	+0.08
	CH	7397	183227	B9	5.84	+0.01
	RS	7404	183387	K2	6.25	+1.32
2 ES Vul	V1	7318	180968	B0.5IVe	5.4	
12 Vul	V2	7565	187811	B3Ve	4.9	
13 Vul	CO	7592	188260	A0III	4.58	-0.06
9 Vul	CH	7437	184606	B7V	4.99	-0.07
β Sge	RS	7488	185958	G8II	4.37	+1.05
V1339 Aql	V	7554	187567	B2e	6.4	
	CO	7562	187753	A0	6.26	+0.10
υ Aql	CH	7519	186689	A2	5.91	+0.18

TABLE I (Continued)

Star	S	HR	HD	Sp. Type	V	B-V
25 Cyg	V1	7647	189687	B3Ve	5.2	
28 Cyg	V2	7708	191610	B3Ve	5.0	
P Cyg	V3	7763	193237	Be	4.8	
λ Cyg	V4	7963	198183	B5Ve	4.5	
22 Cyg	CO	7613	188892	B6III	4.95	-0.09
36 Cyg	CH	7769	193369	A3V	5.56	+0.07
27 Cyg	RS	7689	191026	K0IV	5.33	+0.85
20 Vul	V1	7719	192044	B7Ve	5.9	
QR Vul	V2	7739	192685	B3Ve	4.8	
25 Vul	V3	7789	193911	B1IVe	5.4	
17 Vul	CO	7688	190993	B3V	5.066	-0.163
18 Vul	CH	7711	191747	A3III	5.53	+0.08
19 Vul	RS	7718	192004	K3II-III	5.49	+1.41
	V	7803	194244	B9e	6.1	
	CO	8014	199280	B9	6.57	-0.10
55 Cyg	V1	7977	198478	B3Iae	4.8	
	V2	8020	199478	B8Iae	5.7	
59 Cyg	V3	8047	200120	B1IVe	4.6	
60 Cyg	V4	8053	200310	B1Ve	5.4	
MWC 363	V5	8103	201733	B3e	6.5	
	CO	----	199311	A2V	6.68	+0.05
	CH	----	199479	B9V	6.80	-0.04
MWC 356	V	8009	199218	B6e	6.4	
	CO	8036	199892	B9	6.16	-0.08
	CH	----	200030	B9	6.48	-0.08
υ Cyg	V	8146	202904	B2Ve	4.4	
70 Cyg	CO	8215	204403	B3V	5.30	-0.153
72 Cyg	RS	8255	205512	K1III	4.91	+1.08
16 Peg	V1	8356	208057	B3Ve	5.1	
25 Peg	V2	8438	210129	B7Ve	5.8	
32 Peg	CO	8522	212097	B8V	4.81	+0.00
	CH	8341	207563	B3V	6.28	-0.10
ο And	V	8762	217675	B6e	3.6	
10 Lac	CO	8622	214680	O9	4.88	-0.20
	CH	8733	217101	B2IV-V	6.17	-0.15
2 And	RS	8766	217782	A2	5.103	+0.092
EW Lac	V1	8731	217050	B4e	5.3	
KX And	V2	----	218393	Bpe	6.9	
KY And	V3	----	218674	B3e	6.7	
5 And	CO	8805	218470	F5V	5.688	+0.433
	CH	8705	216523	B8V	6.46	-0.04

12 Vulpeculae: This star brightened by 0^m.1 in V about JD2446260, then slowly faded (Fig. 3). During the summer of 1986 it slowly faded by 0^m.07 in V. In each case, $\Delta(B - V) \sim -0.3 \Delta V$.

25 Cygni: Percy, Jakate, and Matthews (1981) suspected that this star showed very small (0^m.01) variations on a time scale of hours, but the present observations do not confirm that suspicion. There appear to be small variations on longer time scales. Note that 27 Cyg, the red standard for this group of variables, is slightly variable (Percy *et al.* 1986).

28 Cygni: Several observers (e.g., Spear, Mills, and Snedden 1981) have reported variations on a time scale of about 0.7 day and an amplitude of up to 0^m.1. Our observations confirm the presence of variations on a similar time scale during each observing season (Fig. 4).

P Cygni: Our observations of this star have been published separately (Percy *et al.* 1988).

HR 7739: This star is suspected to be an 11-day spectroscopic binary, but this result is in doubt. The star was found to be variable by Pavlovski *et al.* (1983). We find slight variations during each observing season. In the summer of 1986 it faded slowly by 0.06 in V, with $\Delta(B - V) \sim -0.3 \Delta V$ (Fig. 4).

55 Cygni: This B3 Iae star showed small variations on a time scale of weeks to months (Fig. 5), a result consistent with previous observations of this star (Hill, Hilditch, and Pfannenschmidt 1976) and other supergiants (Maeder 1980). There appear to be no short-term variations.

59 Cygni: This star showed slight variations on a time scale of days (Fig. 5).

60 Cygni: Harmanec *et al.* (1986) reported radial velocity and light variations in this star, with a period of perhaps 2.48 days. Our observations confirm the light variability, and the time scale of a day or so, but they do not fit the period of 2.48 days.

TABLE II

Summary of Observations of Program Stars
Column N gives the total number of observations in the
year. Asterisks indicate that more than one observation
of the star was made on most nights.

Star	Year	N	JD 244...	Range in V	Range in B
8 Dra	1984	8	5841-5894	5.221-5.307	5.452-5.591
ν^2 Boo	1981	13*	4773-4807		5.060-5.117
	1984	8	5841-5922	4.994-5.101	5.069-5.212
θ CrB	1981	21*	4741-4793		4.011-4.061
	1985	21	6223-6294	4.124-4.157	3.982-4.016
	1986	29	6579-6664	4.112-4.206	3.993-4.081
	1987	12	6970-7031	4.062-4.330	3.984-4.112
4 Her	1981	13*	4773-4807		5.600-5.662
88 Her	1982	24	5098-5207	6.717-6.768	6.579-6.645
	1984	10	5841-5937	6.655-6.804	6.527-6.668
66 Oph	1981	24*	4741-4817		4.499-4.573
	1982	12	5099-5152	4.625-4.696	4.559-4.666
	1985	20	6223-6294	4.666-4.739	4.623-4.685
MWC 601	1982	9	5099-5152	6.125-6.177	6.108-6.183
	1984	15	5841-5937	6.143-6.225	6.120-6.202
	1986	42*	6579-6664	6.075-6.177	6.058-6.161
	1987	8	6998-7031	6.106-6.166	6.084-6.120
CX Dra	1981	29*	4741-4842		5.741-5.861
	1982	21	5098-5207	5.713-5.962	5.668-5.876
	1984	17	5841-5937	5.674-5.934	5.560-5.852
	1985	21	6223-6294	5.837-5.936	5.777-5.848
	1986	23	6579-6664	5.705-5.899	5.682-5.817
	1987	11	6970-7039	5.736-5.870	5.686-5.795
V923 Aql	1981	22*	4773-4842		6.011-6.146
	1984	9	5841-5937	6.049-6.169	6.020-6.121
	1986	39*	6579-6664	6.077-6.134	6.039-6.126
	1987	5	7013-7031	6.032-6.060	6.014-6.036
V1294 Aql	1982	9	5099-5152	6.897-7.055	6.952-7.111
	1986	39*	6579-6664	6.867-6.983	6.874-6.985
	1987	5	7013-7031	6.930-6.989	6.957-7.002
2 Vul	1985	31*	6223-6294	5.414-5.479	5.434-5.491
	1986	33*	6579-6664	5.405-5.512	5.416-5.509
	1987	8	6970-7028	5.424-5.502	5.434-5.501
12 Vul	1985	31*	6223-6294	4.782-4.903	4.649-4.742
	1986	33*	6579-6664	4.859-4.932	4.708-4.760
	1987	8	6970-7028	4.924-4.969	4.741-4.774
V1339 Aql	1982	11	5099-5152	6.397-6.448	6.361-6.384
	1984	5	5841-5937	6.478-6.532	6.402-6.449
25 Cyg	1982	8	5099-5152	5.144-5.176	4.994-5.031
	1985	45*	6223-6299	5.169-5.203	5.019-5.050
	1986	25	6579-6664	5.140-5.180	5.007-5.064
	1987	16	6971-7031	5.123-5.170	4.999-5.026
28 Cyg	1981	18*	4756-4842		4.764-4.847
	1982	8	5099-5152	4.951-5.009	4.777-4.849
	1985	44*	6223-6299	4.893-5.034	4.754-4.900
	1986	48*	6579-6664	4.890-5.002	4.735-4.852
	1987	17	6971-7031	4.952-5.047	4.773-4.867
λ Cyg	1982	8	5099-5152	5.877-5.952	5.661-5.725
P Cyg	1984	12	5841-5937	4.665-4.890	5.076-5.228
	1985	45*	6223-6299	4.735-4.882	5.150-5.272
	1986	26	6579-6664	4.770-4.885	5.166-5.272
	1987	8	6970-7030	4.770-4.836	5.168-5.225
HR 7739	1982	8	5099-5152	4.757-4.800	4.574-4.615
	1985	27*	6223-6294	4.713-4.773	4.554-4.604
	1986	26*	6579-6664	4.715-4.781	4.560-4.614
	1987	6	6970-7039	4.747-4.801	4.575-4.607
20 Vul	1982	6	5099-5144	5.912-5.946	5.764-5.810
25 Vul	1982	6	5099-5144	5.511-5.541	5.401-5.441
HR 7803	1982	3	5134-5152	6.115-6.141	6.084-6.112
55 Cyg	1986	45*	6579-6664	4.816-4.888	5.169-5.224
	1987	7*	7011-7039	4.846-4.873	5.187-5.213
59 Cyg	1986	44*	6579-6664	4.754-4.818	4.647-4.731
	1987	7*	7011-7039	4.752-4.778	4.629-4.675

TABLE II (Continued)

Star	Year	N	JD 244...	Range in V	Range in B
60 Cyg	1986	44*	6579-6664	5.345-5.425	5.119-5.187
	1987	7*	7011-7039	5.383-5.421	5.140-5.187
HR 8020	1986	23	6579-6664	5.654-5.809	6.071-6.168
	1987	4	7011-7039	5.693-5.756	6.100-6.156
MWC 363	1986	23	6579-6664	6.593-6.629	6.411-6.501
	1987	4	7011-7039	6.604-6.614	6.421-6.424
MWC 356	1982	9	5015-5152	6.641-6.693	6.568-6.631
	1984	10	5841-5937	6.613-6.764	6.563-6.653
ν Cyg	1982	8	5105-5152	4.314-4.391	4.223-4.295
16 Peg	1982	4	5134-5152	5.061-5.090	4.945-4.955
25 Peg	1982	4	5134-5152	5.649-5.775	5.628-5.687
$\circ$ And	1981	3*	4842-4842		3.473-3.499
	1987	25*	7003-7020	3.599-3.678	3.514-3.573
EW Lac	1981	13*	4783-4842		5.097-5.167
KX And	1985	30*	6278-6299	6.889-6.957	7.234-7.305
	1986	57*	6612-6664	6.982-7.133	7.294-7.525
	1987	24*	7003-7028	6.912-7.062	7.239-7.372
KY And	1985	30*	6278-6299	6.703-6.812	6.701-6.802
	1986	57*	6612-6664	6.724-6.782	6.707-6.786
	1987	24*	7003-7028	6.720-6.827	6.702-6.814

MWC 356: Our observations are scanty, but they seem to show slight variations on a time scale of days.

$\circ$ Andromedae: Harmanec (1984) has suggested that the brightness variations of this bright shell star can be explained by the superposition of a long-term (several years) variation of amplitude $0^m.1$ in B and V and a short-term variation with a period of 1.571272 days. The amplitude of the short-term variation is itself variable and is perhaps correlated with the long-term variation. The 1983 campaign on $\circ$ And (Stagg *et al.* 1988) confirmed the short-term variations and their approximate period. Our 1987 observations were made as part of another campaign on this star. They show moderately large variations (Fig. 5). A detailed analysis of these observations will be published elsewhere.

EW Lacertae: This was one of the first Be stars in which short-term variations were observed. The 1983 campaign (Stagg *et al.* 1988) confirmed these variations and showed that their amplitude could change on a time scale of a day or two. The variations were complex but seemed to show a period of about 0.72 day, in agreement with the results of previous observations. Our observations also show the short-term variations but are too sparse to draw any other conclusions.

KX Andromedae: This star is known to be an interacting binary with a period of 38.9 days (Kříž and Harmanec 1975), showing light and color variations on the same time scale (Harmanec *et al.* 1977, 1980a). The 1983 campaign (Stagg *et al.* 1988) showed the presence of short-term variations in this star, with a possible period of 0.47 day. The light curve based on this period is not entirely convincing, however, so the period is in need of confirma-

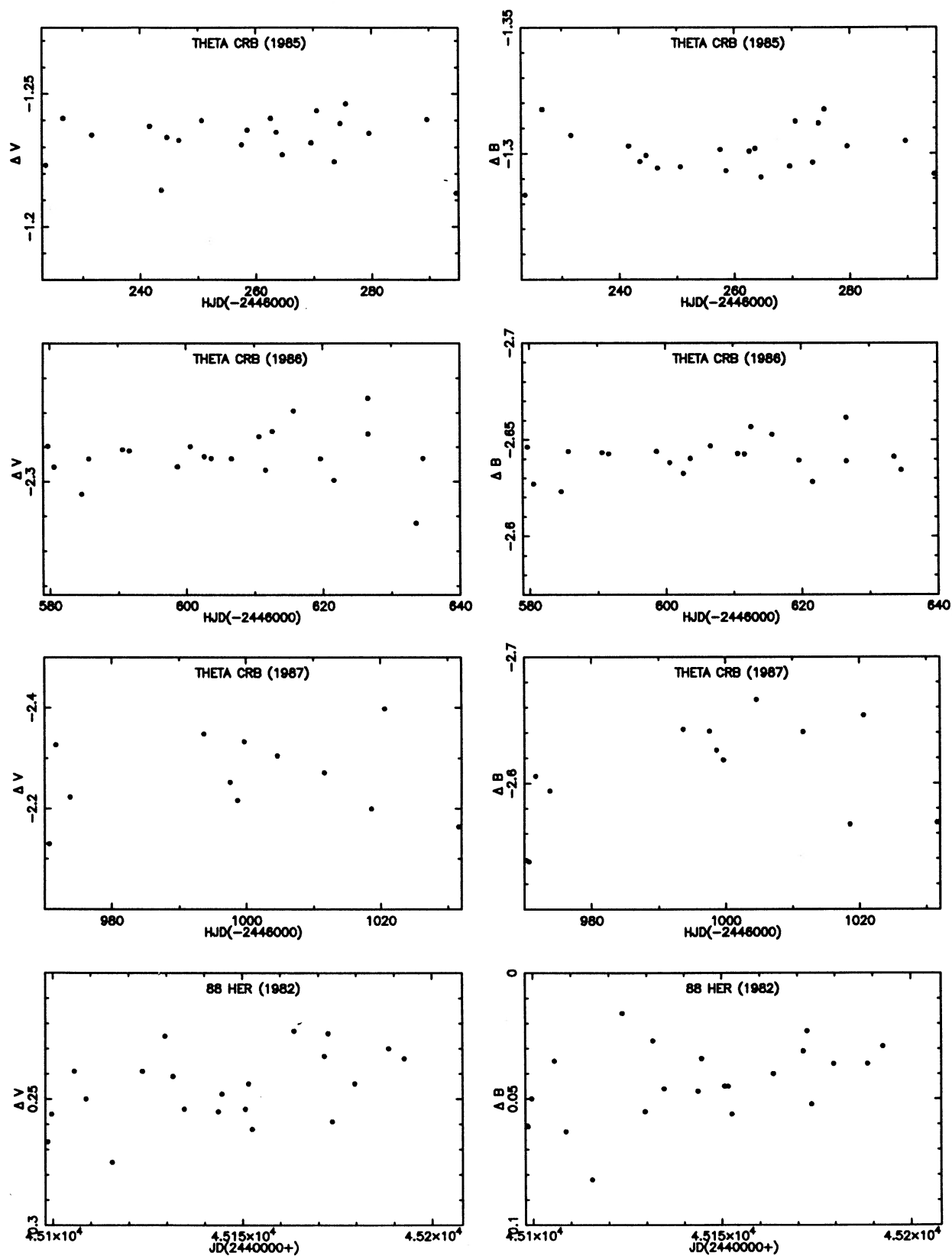


FIG. 1— V and B light curves of θ Cr B and 88 Her. Note that the vertical and horizontal scales are not the same on all light curves. The light curve of a nonvariable check star is shown in Figure 7. The precision of each observation is about $0^m.007$.

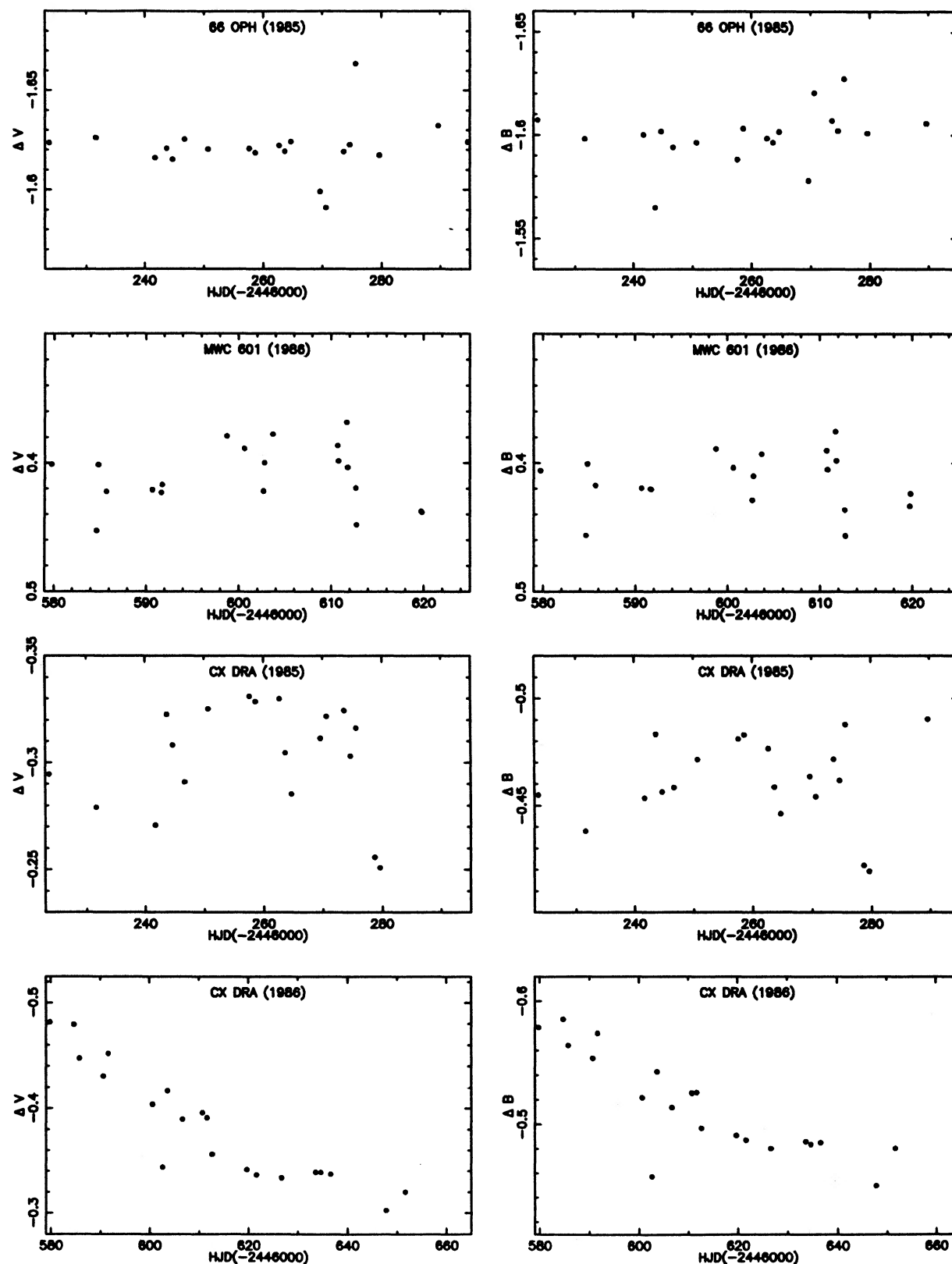


FIG. 2—V and B light curves of 66 Oph, MWC 601, and CX Dra. Note that the vertical and horizontal scales are not the same on all light curves. The light curve of a nonvariable check star is shown in Figure 7. The precision of each observation is about $0^m.007$.

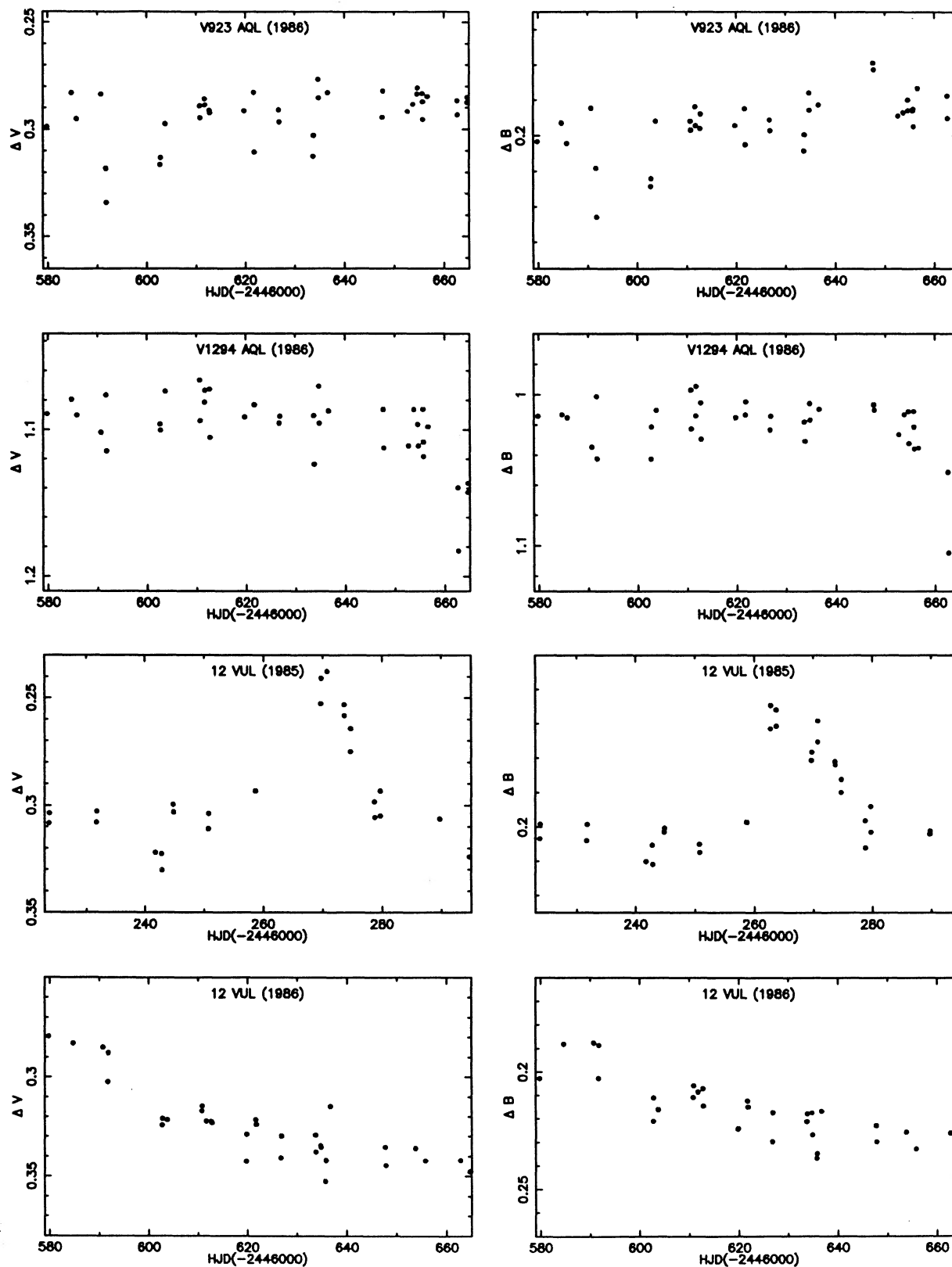


FIG. 3-V and B light curves of V923 and V1294 Aql and 12 Vul. Note that the vertical and horizontal scales are not the same on all light curves. The light curve of a nonvariable check star is shown in Figure 7. The precision of each observation is about 0^m007 .

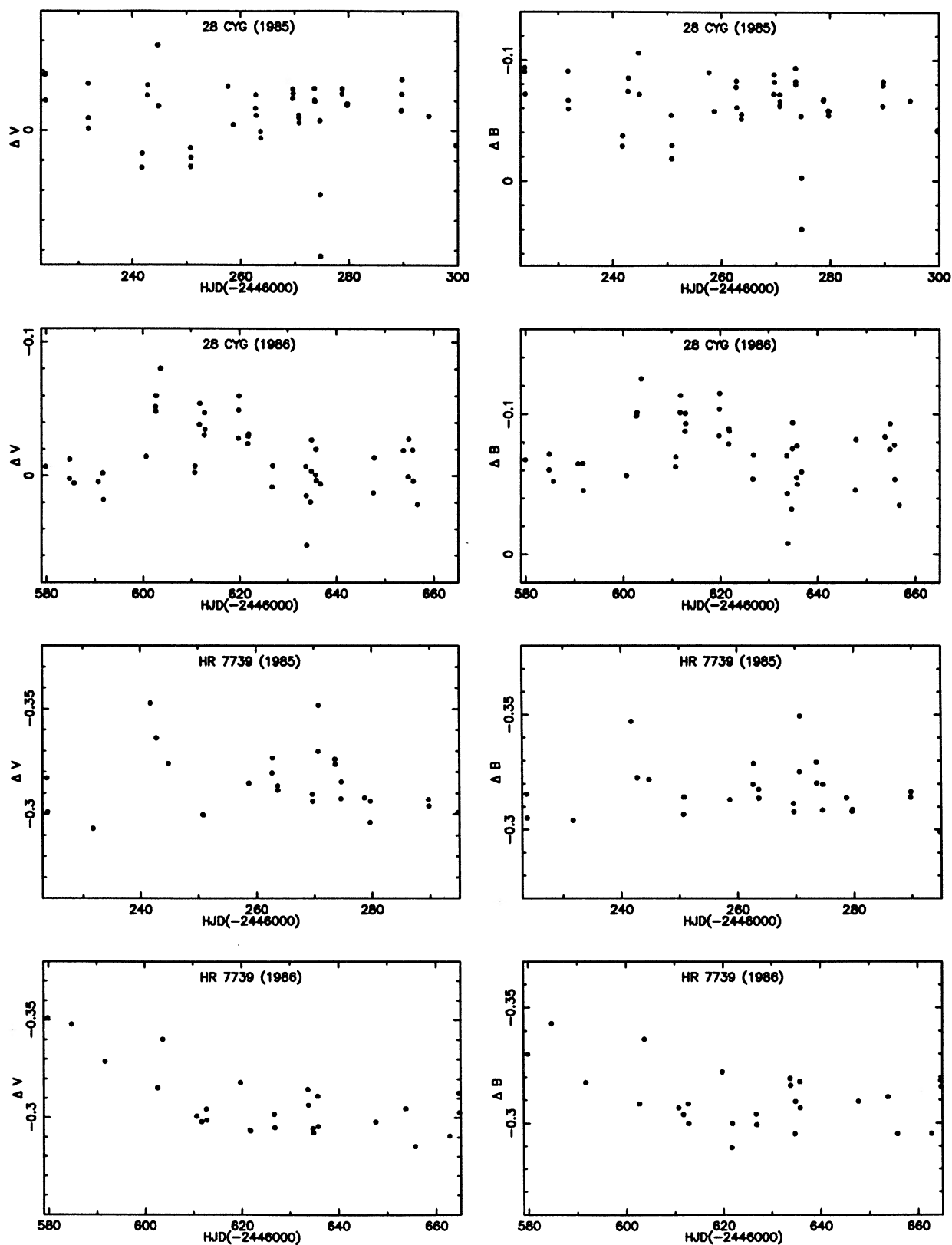


FIG. 4—V and B light curves of 28 Cyg and HR 7739. Note that the vertical and horizontal scales are not the same on all light curves. The light curve of a nonvariable check star is shown in Figure 7. The precision of each observation is about $0^m.007$.

tion. Our observations are shown in Figures 5 and 6.

KY Andromedae: This star has been known for some time to show short-term light variations, and an analysis by Pavlovski (1983) indicated a possible period of 0.714 day, although several other periods seem to be present in his data. The 1983 campaign indicated that the variations are quite complex: A period of 0.361715 day was found in the first interval of data and a period of 0.8469 day in the second, but neither of these periods fitted the data in the other interval. Our 1987 observations were made as part of a second campaign in which this star was a secondary target. Our observations are shown in Figures 6 and 7.

IV. Discussion

The results of our monitoring will be most useful if combined with other observations. The long-term and medium-term photometric variations may be accompanied by spectroscopic variations, for instance. We would be pleased to hear from spectroscopists who have made contemporaneous observations of our program stars. Our observations can also be combined with other contemporaneous photoelectric observations, in order to obtain a more complete picture of the medium-term and long-term variations.

The most effective way to study the short-term variability of Be stars is to combine observations made contemporaneously from different longitudes. We plan to analyze our observations of short-term variables on a star-by-star basis, in collaboration with observers from other longitudes. We would be pleased to hear from photometric observers who have suitable observations and are interested in a collaborative study.

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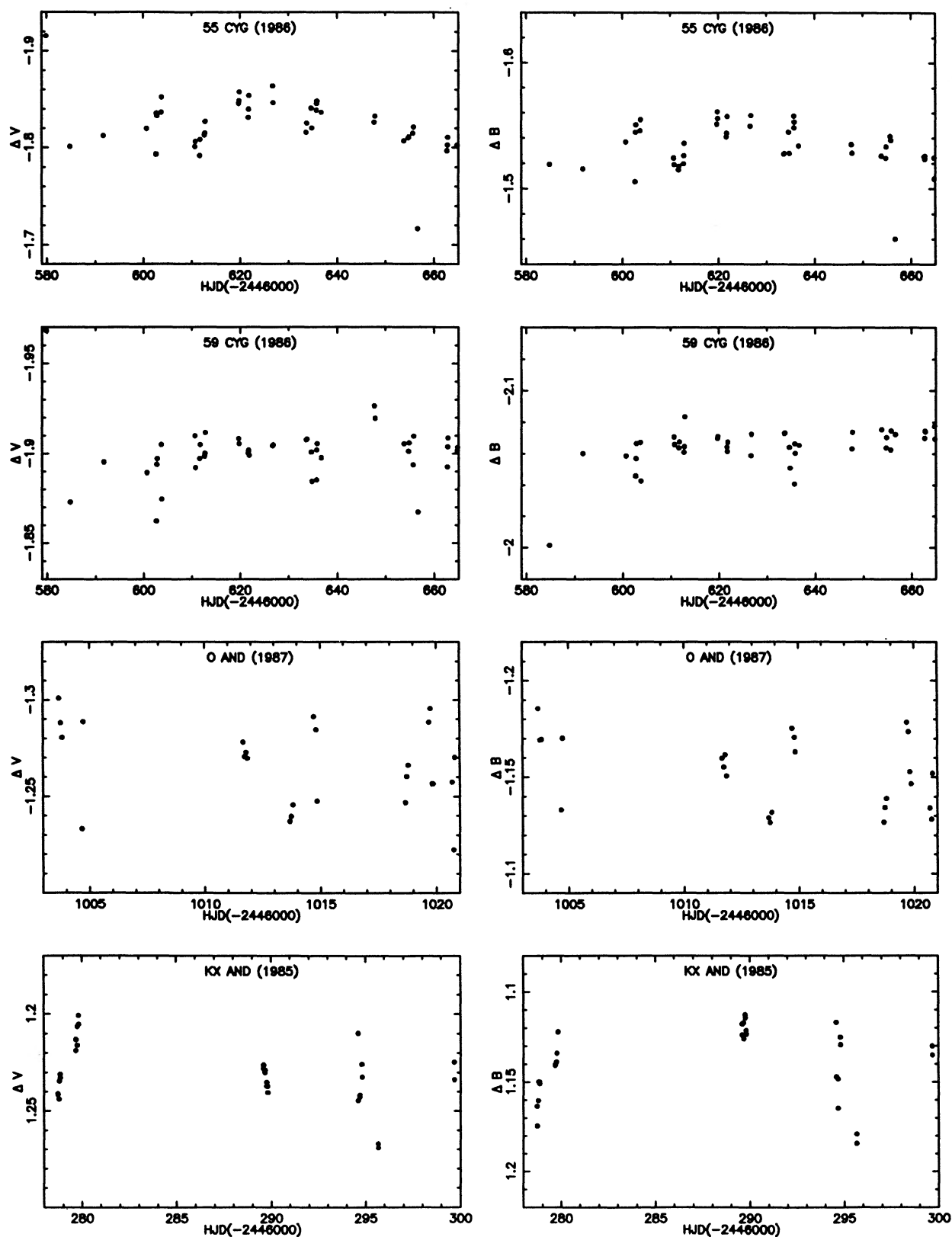


FIG. 5— V and B light curves of 55 and 59 Cyg and o and KX And. Note that the vertical and horizontal scales are not the same on all light curves. The light curve of a nonvariable check star is shown in Figure 7. The precision of each observation is about 0^m007 .

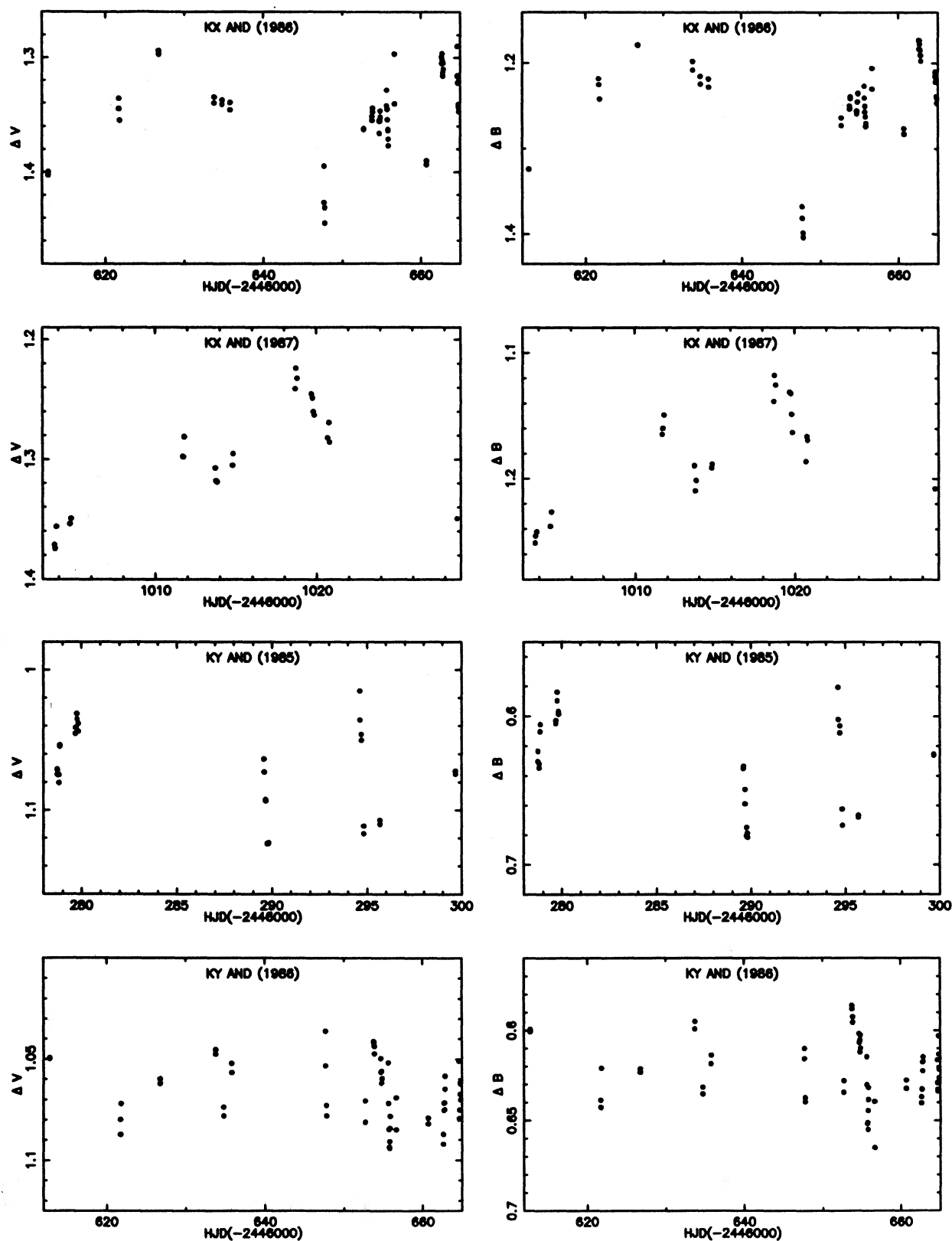


FIG. 6—V and B light curves of KX and KY And. Note that the vertical and horizontal scales are not the same on all light curves. The light curve of a nonvariable check star is shown in Figure 7. The precision of each observation is about $0^m.007$.

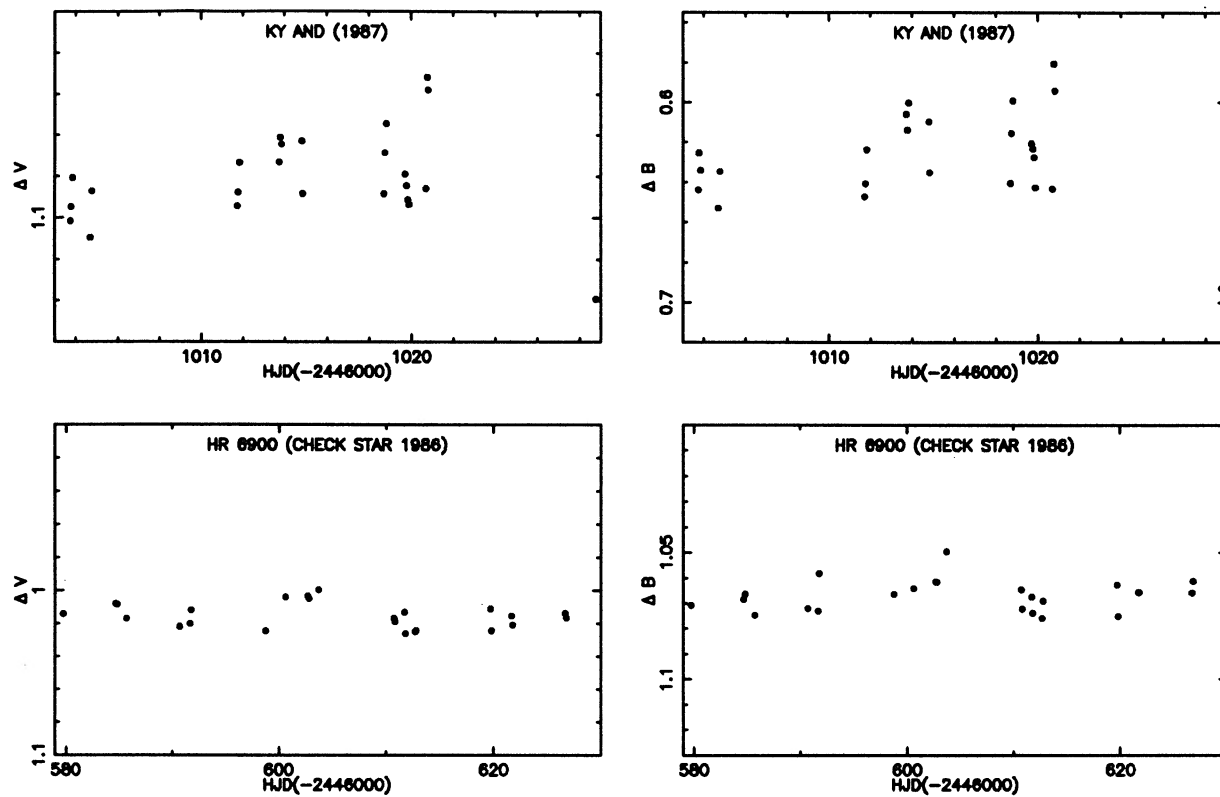


FIG. 7— V and B light curves of KY And and of a nonvariable check star HR 6900. Note that the vertical and horizontal scales are not the same on all light curves. The precision of each observation is about 0^m007 .