

Recent photometry of symbiotic stars - XII*

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We present new photometric observations of 15 symbiotic stars covering their last orbital cycle(s) from 2003.9 to 2007.2. We obtained our data by both classical photoelectric and CCD photometry. Main results are: EG And brightened by ~ 0.3 mag in U from 2003. A ~ 0.5 mag deep primary minimum developed in the U light curve (LC) at the end of 2006. Z And continues its recent activity that began during the 2000 autumn. A new small outburst started in summer of 2004 with the peak U -magnitude of ~ 9.2 . During the spring of 2006 the star entered a massive outburst. It reached its historical maximum at $U \sim 8.0$ in 2006 July. AE Ara erupted in 2006 February with $\Delta m_{\text{vis}} \sim 1.2$ mag. BF Cyg entered a new active stage in 2006 August. A brightness maximum ($U \sim 9.4$) was measured during 2006 September. CH Cyg persists in a quiescent phase. During 2006 June – December a ~ 2 mag decline in all colours was measured. CICYg started a new active phase during 2006 May – June. After 31 years it erupted by about 2 mag in U . TX CVn maintains a bright stage with $U \sim 10.5$ from 2003. AG Dra entered a new major outburst in 2006 June. It reached its maximum at $U \sim 8.0$ in 2006 September. AR Pav persists at a low level of the activity. AG Peg's LC profile varies markedly during different orbital cycles. AX Per continues its quiescent phase.

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1 Introduction

Symbiotic stars are long-period ($P_{\text{orb}} \sim 1 - 3$ years) interacting binary systems consisting of a late-type giant and a hot compact star accreting from the giant's wind. This process generates a very hot ($T_{\text{h}} \approx 10^5$ K) and luminous ($L_{\text{h}} \approx 10^2 - 10^4 L_{\odot}$) source of radiation that ionizes a fraction of the neutral wind from the giant giving rise to nebular emission. As a result the observed spectrum of symbiotic stars composes from three basic components of radiation – two stellar and one nebular. Throughout the optical their contributions rival each other, producing the composite spectrum, whose colour indices differ significantly from those of standard stars. In addition, they are different for individual objects and variable due to activity and/or the orbital phase (cf. models SED in Skopal 2005). Therefore the LCs of symbiotic binaries bear a great deal of information about properties of the radiative sources in the system. Photometric monitoring is important to complement other multifrequency observations, mainly during outbursts, to improve our understanding of the observed phenomena (e.g. Sokoloski 2003).

In this paper we present results of our long-term monitoring programme of photometric observations of selected symbiotic stars, originally launched by Hric & Skopal (1989). It continues the work of Skopal et al. (2004, hereafter S+04) by collecting new data obtained during the period 2003 December to 2007 January. Their acquisition and reductions are introduced in Sect. 2. In Sect. 3 we note the most interesting features of the LCs that deserve further investigation. The results are presented in Tables 1–18 and Figs. 1–12.

2 Observations and reductions

Observations made at the Skalnaté Pleso (hereafter SP in Tables), Stará Lesná (G2 pavilion) and the Rozhen Observatory with the Schmidt telescope (R) were already described by S+04. Further details about the observation procedure were described by Hric et al. (1991). Other UBV photoelectric observations were obtained with the modular photometer utilizing a Hamamatsu EA1516 photomultiplier on the 0.5-m telescope at the Sutherland site of the South Africa Astronomical Observatory (SAAO) during two weeks in April and May 2004 and September 2005. The photoelectric measurements were done in the UBV filters of the Johnson's photometric system with a 20 second integration time. Observations were reduced to the Cousins E-region standard system (Menzies et al. 1989) and corrected for differential extinction using the reduction program HEC 22 rel. 14 (Harmanec & Horn 1998). Observations of Draco C-1 in the

* Tables 1–18 are also available in electronic form at <http://www.astro.sk/~astrskop/>

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standard Johnson-Cousins system were made with the photometric AT-200 CCD camera (1024×1024 px, pixel size: 24×24 μm, scale: 0.33 arcsec/px, field: 5.6×5.6 arcmin) on the 2-m telescope at the Rozhen Observatory. Additional BVR_{CIC} CCD photometry was obtained with the 0.5-m telescope at the Stará Lesná Observatory (G1 pavilion). The SBIG ST10 MXE CCD camera with the chip 2184×1472 pixels was mounted at the Newtonian focus. The size of the pixel is 6.8 μm and the scale 0.56"/pixel. All frames were dark-subtracted, flat-fielded and corrected for cosmic rays. Other details of the CCD photometric reduction were described by Parimucha & Vaňko (2005).

In addition, visual magnitude estimates of AE Ara, RW Hya and AR Pav were obtained by one of us (AJ) with a private 12".5 f/5 reflector. A comparison between V magnitudes and corresponding visual estimates suggests their uncertainties to be within about 0.2 mag for brighter objects (RW Hya, AR Pav) and 0.3 mag for AE Ara during quiescence ($m_{\text{vis}} \geq 13$ mag).

We measured our targets with respect to the same standard stars as in our previous papers (e.g. S+04) if not specified otherwise in Sect. 3. Results are summarized in Tables 1–18 and shown in Figs. 1–12. Each value represents the average of the observations during a night. The maximum internal uncertainty of these night-means is less than 0.05 mag. We verified the absolute photometry by comparing our data with those obtained independently at other observatories.

3 Notes to measured objects

3.1 EG And

EG And is a quiet symbiotic star – no outburst of the Z And type has been recorded to date. Photometric measurements are listed in Table 1 and plotted in Fig. 1. From 2003 the U -LC indicates a brighter stage of EG And by about 0.3 mag. According to the ephemeris of Skopal (1997), a deep primary minimum ($\Delta U \geq 0.5$ mag) was observed during 2006 October to December. By a precise modeling the UV/optical continuum, Skopal (2005) showed that the brightening in the U passband can be caused by an increase in the nebular emission. This could be a result of a transient increase in the mass-loss rate from the giant and thus also the accretion rate and the luminosity of the hot component. Consequently this process increases flux of ionizing photons that gives rise the larger amount of the nebular radiation.

3.2 Z And

Z And is a prototype symbiotic star. The star BD+47 4192 ($V = 8.99$, $B - V = 0.41$, $U - B = 0.14$, $V - R_C = 0.10$) was used as the comparison for both photoelectric and CCD observations (Tables 2 and 3, Fig. 2). They revealed two new eruptions. The first one started in 2004 July/August and peaked at $V \sim U \sim 9.2$ mag in the mid September with

a following re-brightening in 2004 December. Then a slow decrease in the star's brightness was observed to the end of 2005. The second major eruption started during the spring of 2006 and peaked in 2006 July, when the star's brightness reached its historical maximum ($U \sim 8.0$, $V \sim 8.5$) that has ever been recorded by the multicolour photometry. It is of interest to note that spectral features indicating ejection of highly collimated bipolar jets developed during the optical maximum (Skopal & Pribulla 2006). Their evidence in the optical spectra was confirmed by Burmeister & Leedj arv (2007) and Tomov et al. (2007).

3.3 AE Ara

Our observations of AE Ara consists of 488 visual estimates made by one of us (AJ) carried out from 1987 to 2006.9 and photoelectric UBV measurements made on 25/04/2005 at SAAO (JD 2 453 122.596: $V = 12.402$, $B - V = 0.607$, $U - B = -1.044$) We used the standard star HD 317858 (CD-32 12919; $V = 9.533$, $B - V = 0.143$, $U - B = -0.523$). Results are shown in Fig. 3. There is a good agreement between the visual estimates and our photoelectric V magnitude. The very negative $U - B$ index of AE Ara suggests a strong contribution from the nebula at the U passband. During the 2000-05 period a wave-like variation developed in the LC. The time of the best defined minimum at JD 2 453 474±20 agrees (within the uncertainties) with that predicted by the ephemeris of Mikolajewska et al. (2003). Also the time of the previous minimum, we estimated to \approx JD 2 452 710, is close (within 0.07 of the orbital period) to the predicted one. This implies that this light variation was due to the orbital motion (see Mikolajewska et al. 2003 in detail). We note that a large scatter in our visual magnitudes did not allow us to estimate the position of the first minimum more accurately.

During 2006 February AE Ara entered a new active phase. Our visual observations revealed a rapid increase in the star's brightness by about 1.2 mag. It peaked at $m_{\text{vis}} \sim 11.2$ during April and was gradually decreasing to ~ 11.8 in 2006 November before its season observational gap.

3.4 BF Cyg

The resulting night-means of the BF Cyg brightness are in Table 4. Figure 4 shows its UBV LCs covering the last 3 orbital cycles. The maximum between 2004.5 and 2005.5 was complex in profile. First a 0.5 mag increase with respect to values from previous cycles was observed during the second half of 2004. An additional brightening to $U \sim 10.5$ mag was observed in the spring of 2005. The following minimum at JD 2 453 705±12 was by ~ 0.5 mag brighter than those observed previously. In 2006 August the LC revealed an eruption with the peak U -magnitude of ~ 9.4 during the following September. The active phase continues with a slow fading to our last observations at the end of 2006. We note that a similar profile of the LC was also observed during the 1987-

89 period, prior to the 1989 outburst (cf. Fig. 2 of Skopal et al. 1997).

3.5 CH Cyg

Our new photometry of CH Cyg is listed in Table 5. Figure 5 shows LCs from the last 1998-00 activity. From the beginning of 2000 CH Cyg persists in a quiescent phase at rather bright magnitudes ($V = 7 \div 8$, $B = 8.7 \div 9.4$ and $U \approx 10$ or less). The LCs display a wave-like 750÷770-day periodic variation, more pronounced in V , whereas in U the brightness only fluctuated around 10 from about 2003. This suggests that mainly a giant star in the system is responsible for such behaviour. This type of the LC profile developed during each previous post-outburst stage, in 1970 and 1987 (see Fig. 1 of Eyres et al. 2002). During the 2006 June – December period the LCs showed a 2 mag decline in all colours ($\Delta U \sim 1.8$, $\Delta B \sim 2.3$, $\Delta V \sim 2.5$ mag).

3.6 CI Cyg

Photometric measurements of CI Cyg are introduced in Tables 6 and 7 and depicted in Fig. 6. The wave-like variation along the orbital motion indicates a quiescent phase. Such the behaviour developed in 1985, about 10 years after the last outburst in 1975 (cf. Dmitrienko 2000), and continued until the spring of 2006, when a new eruption was detected. A pre-outburst activity was indicated during the recent 2003-06 cycle when the U star's brightness of the 2005-maximum was by about 0.4 mag higher than that of the previous one (Fig. 6). Additional variations were recorded in the V and (in part) B -band LCs. They are probably caused by the red giant whose light dominates these passbands during quiescence (see Fig. 10 in Skopal 2005).

During the 2006 May – June period CI Cyg started its new active phase, when brightened by $\Delta U \sim 2$ mag, $\Delta B \sim 1.2$ mag and $\Delta V \sim 1$ mag.

3.7 V1329 Cyg

Observations of V1329 Cyg (HBV 475) are given in Table 8.

3.8 TX CVn

Table 9 and Fig. 7 summarize photometric measurements of TX CVn. From 2003 the system persists at a higher level of activity with $U \sim 10.5$. Sometimes during the brighter stages, the U -LC shows minima placed at the inferior conjunction of the cool giant (according to the ephemeris of Kenyon & Garcia 1989 for a circular orbit; thick arrows in Fig. 8). However, in some cases no minima were detected in spite of a sufficient coverage of the corresponding part of the LC (crosses in Fig. 8). Another peculiarity concerns to the minima width. The minima are too broad than to be explained by the eclipse of simple stellar photospheres (e.g. $t_3 - t_2 \approx 0.2 P_{\text{orb}}$). This effect deserves further investigation.

3.9 AG Dra

Our measurements of AG Dra are summarized in Tables 10 and 11 and plotted in Fig. 8. The stars "a" ($\alpha_{2000} = 16^{\text{h}}03^{\text{m}}25^{\text{s}}$, $\delta_{2000} = 66^{\circ}37'31''$) and "b" ($\alpha_{2000} = 16^{\text{h}}02^{\text{m}}54^{\text{s}}$, $\delta_{2000} = 66^{\circ}41'34''$) as denoted by Montagni et al. (1996) were used as comparison stars for our CCD measurements. We measured their U , B , V magnitudes with respect to our photometric standard BD+67°925 (a: $V = 10.456 \pm 0.005$, $B = 11.007 \pm 0.008$, $U = 11.059 \pm 0.012$; b: $V = 11.112 \pm 0.007$, $B = 11.858 \pm 0.011$, $U = 12.057 \pm 0.015$). These magnitudes agree within uncertainties with those measured by Henden & Munari (2006). The LCs show flares, maxima of which repeat with a period of approximately 1 year. During these events the colour index $U - B < 0$, whereas during quiescence we observed $U - B \geq 0$ (Fig. 8). This suggests a significant increase of the nebular component of radiation during active phases.

In 2006 June AG Dra began a massive outburst that is similar in profile, but stronger in brightness, to that from 1980-82. It reached the brightness maximum during 2006 September ($U \sim 8.0$) and afterwards was declining gradually to $U \sim 9$ mag in spring of 2007. With the analogy to the 1980-82 active phase, the second eruption could be expected during the summer of 2007.

3.10 Draco C-1

B , V , R_C , I_C magnitudes of Draco C-1 are in Table 12. We used the standard stars from Henden & Munari (2000). There are 12 calibrated stars in the field of Draco C-1 (12×12 arcmin). The stars No. 4, 7, 9, 11 and 12, which were within the field of our 2-m telescope, were selected to calibrate the Draco C-1 measurements.

3.11 RW Hya

The UBV measurements of RW Hya were carried out at SAAO between 2004 April 22 and May 02. Magnitudes are summarized in Table 13 and shown in Fig. 9 together with those published previously by S+04. To compare the available data, which were obtained within a large time period (from 1990 to 2004), we plotted them against the orbital phase. We used the ephemeris for the inferior conjunction of the giant given by the solution of spectroscopic orbit as published by Schild et al. (1996).

3.12 SY Mus

The UBV measurements of SY Mus are listed in Table 14. Observations were carried out at the SAAO on 2004 April. The star HD 100264 (SAO 251442; $V = 8.679$, $B - V = 0.149$, $U - B = -0.153$) was used as a comparison star.

3.13 AR Pav

The UBV measurements of AR Pav are listed in Table 15. Stars CD-66 2195 (GSC 09080-01017: $V = 9.997$, $B - V =$

0.254, $U - B = 0.164$) and HD 269743 (CPD-66 331: $V = 10.514$, $B - V = 0.781$, $U - B = 0.378$) were used as standard stars. Figure 10 shows the recent evolution in the visual LC (from 1998.4 to December 2006), which corresponds to a low stage of the ARPav activity. Compared are also our UBV measurements. The very good agreement between the visual estimates and photoelectric V magnitudes suggests that variations in the visual LC with $\Delta m \geq 0.2$ reflect real changes. Below we point some interesting features in the LC:

(i) A 100–150-day periodic variation developed between epochs 69 and 70. This type of variability occurred sometimes during low levels of the activity. Skopal et al. (2000) ascribed it to pulsations of the red giant in the system.

(ii) A gradual decrease in the ARPav activity is suggested by a slow decline in the U -band brightness. In 1999.6 we observed $U - V < 0$, while in 2004.3 $U - V > 0$, which reflects a decline of the nebular emission and thus also a decrease in the flux of the ionizing photons resulting probably from a temperature decrease of the hot source.

(iii) Positions of the recent two minima, $\text{Min}(69) = \text{JD } 2\,452\,966 \pm 2$ and $\text{Min}(70) = \text{JD } 2\,453\,573.3 \pm 0.7$, differ by 607.3 ± 2.1 days that is by 2.8 days larger than the orbital period ($P_{\text{orb}} = 604.5$ days). We ascribe this difference to a strongly variable size, geometry and radiation of the eclipsing object as already noted by Bruch et al. (1994).

(iv) Mid-points of all the minima from the low state of the activity ($E = 66$ to 70) precede those predicted by the linear ephemeris determined by 4–65 epochs, which confirms a continuous decrease of the orbital period found by Skopal et al. (2000).

3.14 AG Peg

Photometric observations of AG Peg are summarized in Table 16 and depicted in Fig. 11. The LCs show variations in the profile from cycle to cycle. Most pronounced are different levels of maxima/minima and their shaping. For example, the minimum around JD 2 452 900 was flat for about 0.26 of the orbital period. Such behaviour suggests that the symbiotic nebula is variable in both the shape and the emissivity. The former is given by a different projection of the optically thick part of the nebula into the line of sight (Skopal 2001), while the latter can reflect variation in the flux of ionizing photons.

The variation in the V -band LC is probably in part caused by the giant's semiregular variability, because the light contribution from the giant dominates the SED from V (cf. Fig. 20 of Skopal 2005).

3.15 AX Per

The recent measurements of AX Per are introduced in Tables 17 and 18 and showed in Fig. 12. Our CCD frames from the pavilion G1 distinguished two optical components of the star BD+53° 340 ($\alpha_{2000} = 01^{\text{h}}36^{\text{m}}37.98^{\text{s}}$, $\delta_{2000} =$

$54^{\circ}14'41.8''$) in UBV filters. The brighter one (denoted as a) was used as a comparison star for our CCD measurements in Table 18 (a : $V = 9.56$, $B - V = 1.45$ and b : $V = 12.44$, $B - V = 0.53$). The wave-like profile of the LC as a function of the orbital phase reflects a quiescent phase. However, the profile is not simple sinusoidal. Variations during different orbital cycles are evident.

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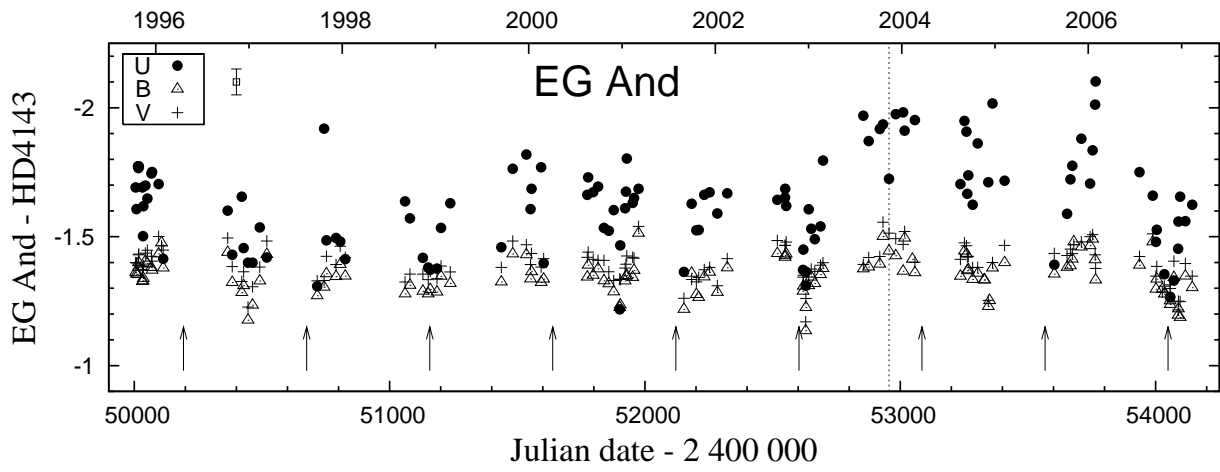


Fig. 1 Differential *UBV* LCs of EG And. Arrows mark positions of the primary minima (ephemeris of Skopal 1997). New data (Table 1) are plotted to the right of the vertical dotted line. The error bar (top left) represents a maximum uncertainty in *U*.

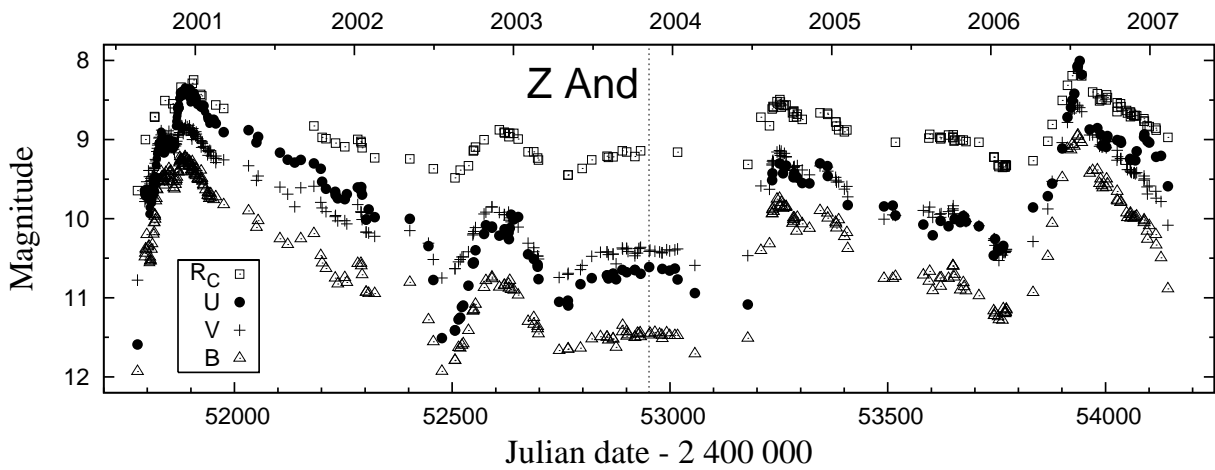


Fig. 2 The *UBVR_C* LCs of Z And covering its recent active phase from 2000. New data are from Tables 2 and 3. Compared are data of Tomov et al. (2004) and Sokolowski et al. (2006) around the 2000-01 maximum.

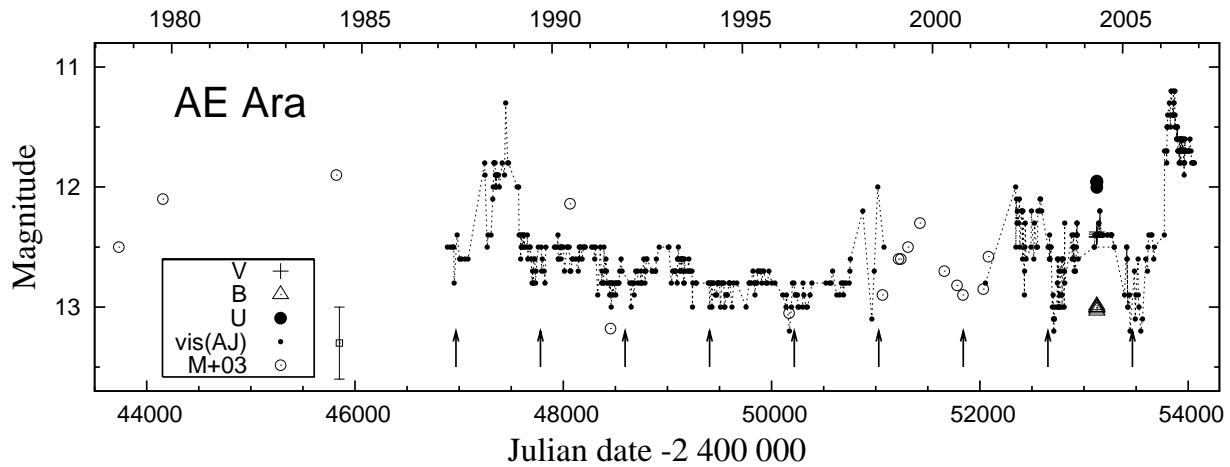


Fig. 3 Our visual LC and *UBV* magnitudes of AE Ara from Sect. 3.3 compiled with those published by Mikolajewska et al. (2003) (open circles). Arrows denote positions of the primary minima according to their ephemeris. New outburst began in 2006 February. The error bar represents a maximum uncertainty of faintest visual estimates.

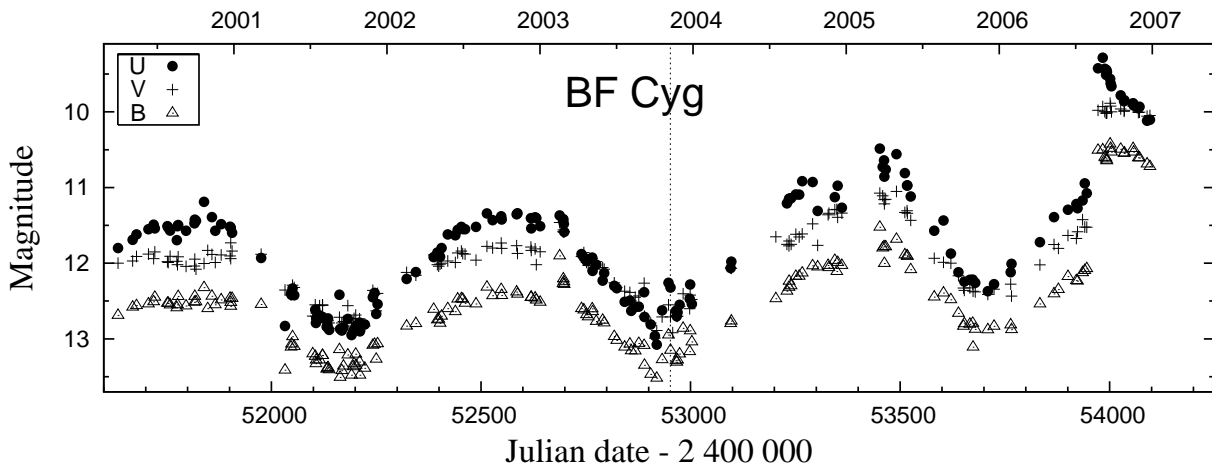


Fig. 4 The *UBV* LCs of BF Cyg revealed a new active stage from 2006 August. Compared are data from Yudin et al. (2005) to 2004.6.

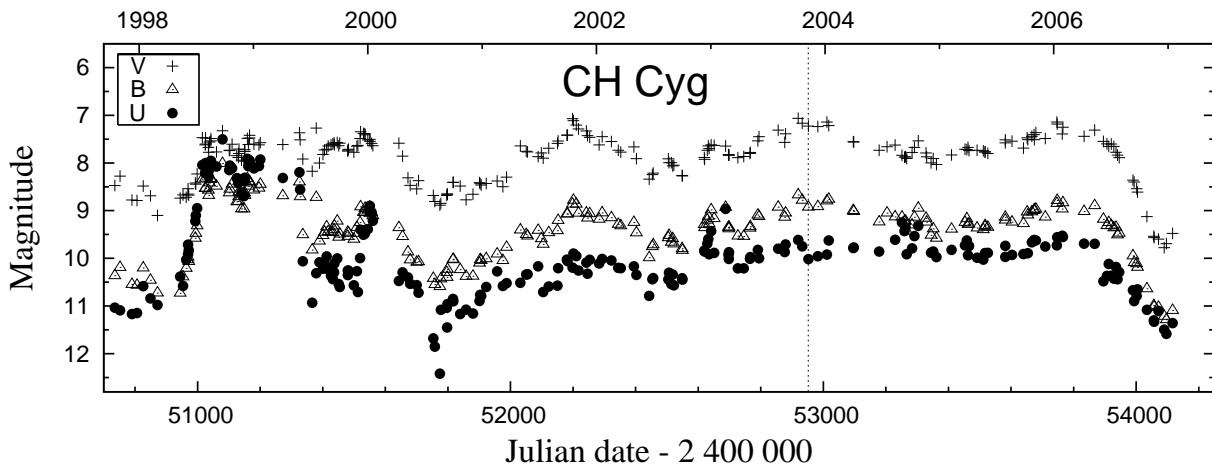


Fig. 5 The *UBV* LCs of CH Cyg.

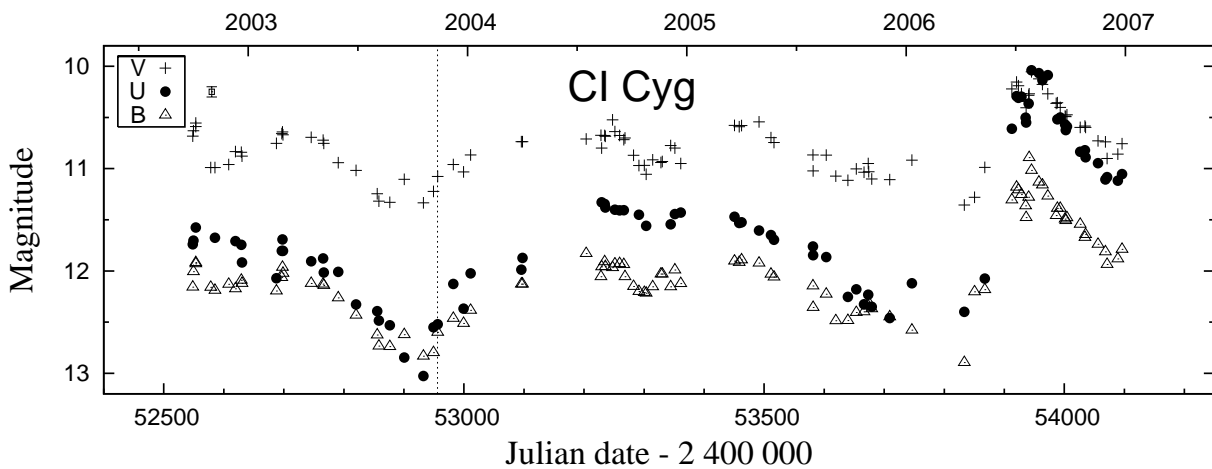


Fig. 6 The *UBV* LCs of CI Cyg revealed a new active stage that began in 2006 June. Maximum uncertainty of individual points is nearly within their size (compare the error bar at the top-left corner).

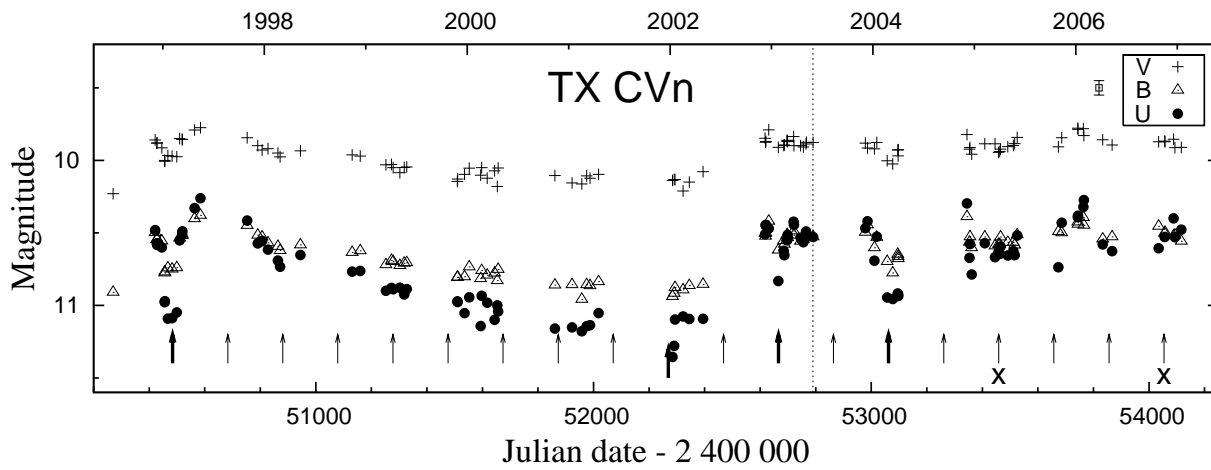


Fig. 7 The *UBV* LCs of TX CVn. Arrows denote positions of the inferior conjunction of the giant (Kenyon & Garcia 1989). Thick arrows mark the appearance of minima, while "x" mark their disappearance during the brighter stages (Sect. 3.8).

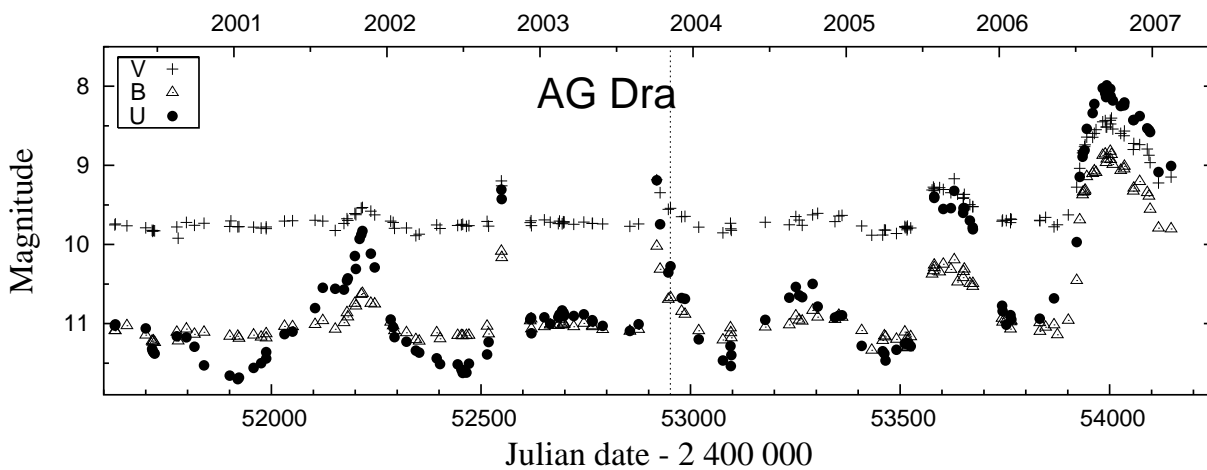


Fig. 8 The *UBV* LCs of AG Dra. New massive outburst started in 2006 June. The data were complemented with those of Leedj rv et al. (2004).

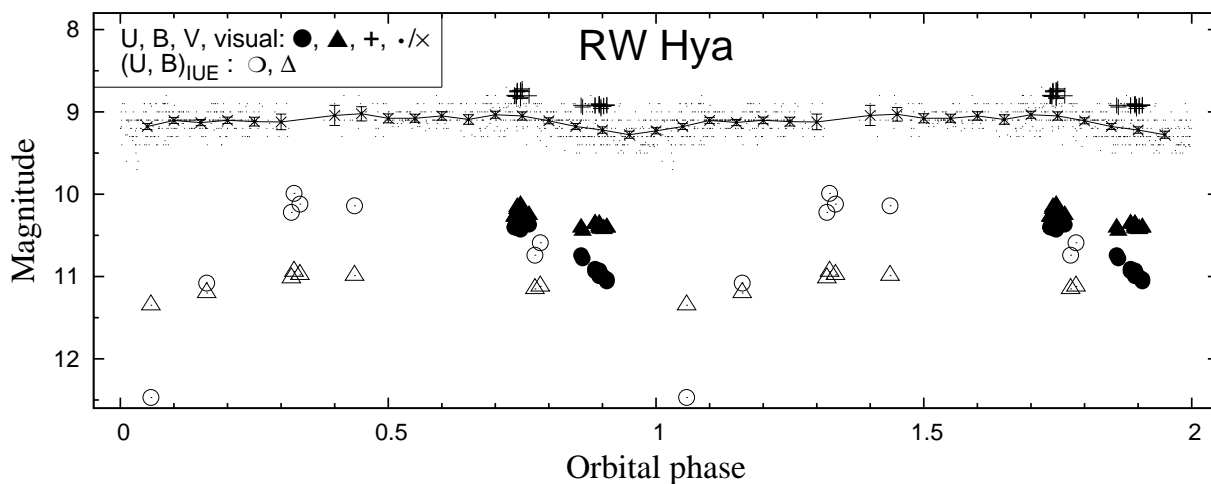


Fig. 9 Our visual LC and *UBV* measurements of RW Hya from Table 13 compiled with those published by S+04 and Munari et al. (1992).

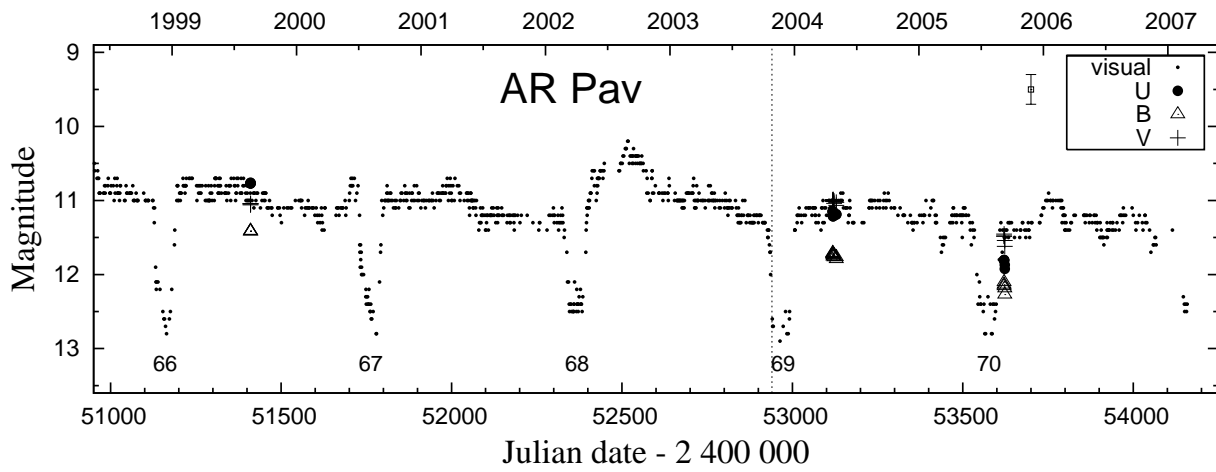


Fig. 10 Our visual LC covering a low stage of activity from 1998.4. New *UBV* points are from Table 15. Numbers 66 – 70 denote the mid-points of eclipses predicted by their linear ephemeris derived by Skopal et al. (2000). The error bar represents a maximum uncertainty of visual estimates.

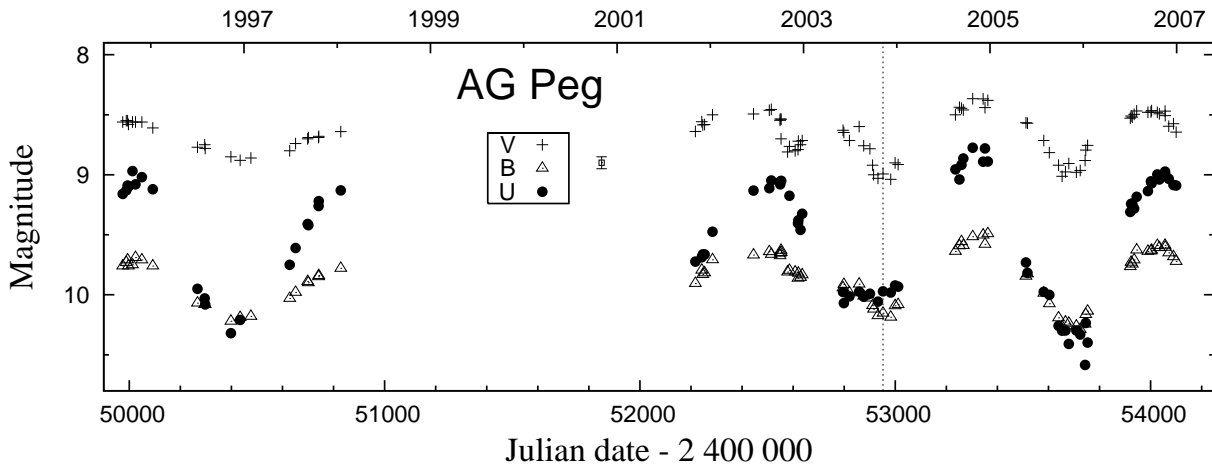


Fig. 11 *UBV* LCs of AG Peg. Data to 1998 are from Tomov & Tomova (1998).

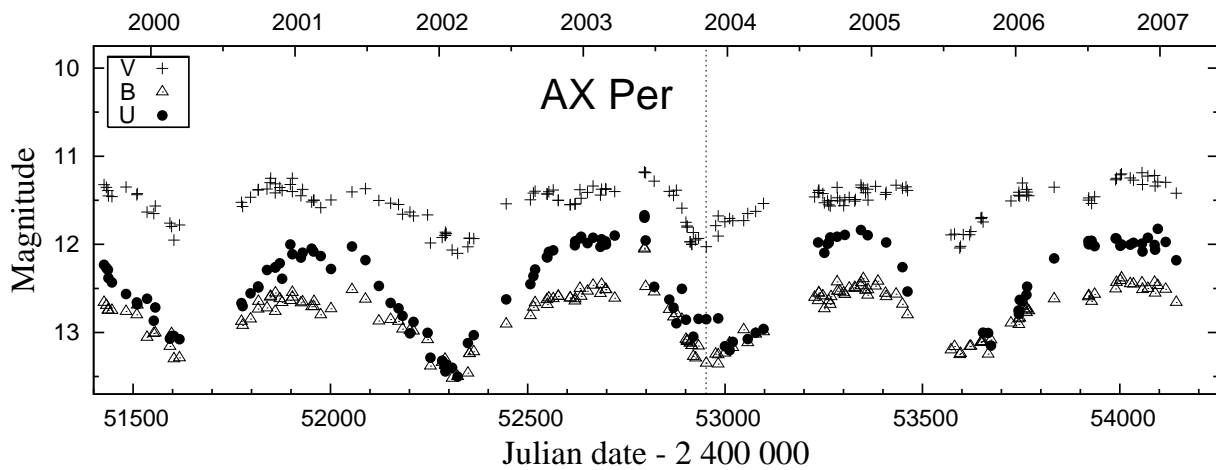


Fig. 12 *UBV* LCs of AX Per. New data are in Tables 17 and 18.

Table 1 U , B , V , R_C observations of EG And.

| Date | JD 24... | ΔU | B | V | ΔR_C | Obs |
|------------|-----------|------------|-------|-------|--------------|-----|
| Nov 12, 03 | 52956.229 | -1.724 | 8.718 | 7.049 | – | G2 |
| Dec 8, 03 | 52982.309 | -1.975 | 8.736 | 7.071 | – | G2 |
| Jan 6, 04 | 53011.312 | -1.982 | 8.796 | 7.093 | – | G2 |
| Jan 12, 04 | 53017.286 | -1.911 | 8.668 | 7.043 | -1.636 | SP |
| Feb 11, 04 | 53047.194 | – | 8.75 | 7.17 | – | R |
| Feb 21, 04 | 53057.256 | -1.952 | 8.802 | 7.162 | – | G2 |
| Aug 18, 04 | 53235.505 | -1.704 | 8.816 | 7.151 | – | G2 |
| Sep 3, 04 | 53251.553 | -1.949 | 8.718 | 7.087 | -1.556 | SP |
| Sep 11, 04 | 53259.509 | -1.907 | 8.729 | 7.098 | -1.530 | SP |
| Sep 14, 04 | 53262.564 | -1.666 | 8.794 | 7.142 | -1.517 | SP |
| Sep 17, 04 | 53266.434 | -1.738 | 8.791 | 7.139 | – | G2 |
| Oct 5, 04 | 53283.560 | -1.624 | 8.828 | 7.183 | -1.477 | SP |
| Oct 25, 04 | 53303.609 | -1.862 | 8.804 | 7.182 | -1.544 | SP |
| Nov 18, 04 | 53328.169 | – | 8.83 | 7.24 | – | R |
| Nov 20, 04 | 53330.410 | – | 8.83 | 7.23 | – | R |
| Dec 4, 04 | 53344.432 | -1.711 | 8.933 | 7.310 | -1.375 | SP |
| Dec 10, 04 | 53350.317 | – | 8.91 | 7.29 | – | R |
| Dec 21, 04 | 53361.400 | -2.017 | 8.784 | 7.163 | -1.517 | SP |
| Feb 6, 05 | 53408.257 | -1.717 | 8.763 | 7.097 | – | G2 |
| Aug 20, 05 | 53603.469 | -1.391 | 8.807 | 7.128 | – | G2 |
| Oct 9, 05 | 53653.481 | -1.589 | 8.781 | 7.136 | -1.537 | SP |
| Oct 23, 05 | 53666.512 | -1.722 | 8.775 | 7.111 | -1.560 | SP |
| Oct 29, 05 | 53673.445 | -1.775 | 8.749 | 7.129 | -1.539 | SP |
| Nov 4, 05 | 53679.479 | – | 8.682 | 7.094 | -1.551 | SP |
| Dec 4, 05 | 53709.413 | -1.880 | 8.702 | 7.083 | -1.570 | SP |
| Jan 7, 06 | 53743.421 | -1.706 | 8.697 | 7.063 | -1.619 | SP |
| Jan 17, 06 | 53753.290 | -1.835 | 8.672 | 7.055 | -1.571 | SP |
| Jan 27, 06 | 53763.252 | -2.012 | 8.752 | 7.133 | -1.548 | SP |
| Jan 29, 06 | 53765.304 | -2.102 | 8.830 | 7.186 | -1.485 | SP |
| Jul 20, 06 | 53936.527 | -1.750 | 8.773 | 7.140 | -1.530 | SP |
| Sep 10, 06 | 53988.589 | -1.659 | 8.682 | 7.052 | -1.610 | SP |
| Sep 22, 06 | 54001.499 | -1.480 | 8.866 | 7.216 | -1.462 | SP |
| Sep 25, 06 | 54004.441 | -1.527 | 8.827 | 7.178 | -1.483 | SP |
| Oct 18, 06 | 54026.617 | – | 8.866 | 7.278 | -1.401 | SP |
| Oct 25, 06 | 54034.450 | -1.354 | 8.885 | 7.255 | -1.423 | SP |
| Nov 16, 06 | 54056.400 | -1.264 | 8.911 | 7.250 | -1.421 | SP |
| Nov 17, 06 | 54057.401 | -1.267 | 8.925 | 7.264 | -1.380 | SP |
| Dec 1, 06 | 54071.396 | -1.330 | 8.821 | 7.158 | -1.507 | SP |
| Dec 18, 06 | 54088.388 | -1.453 | 8.967 | 7.347 | -1.359 | SP |
| Dec 19, 06 | 54089.386 | -1.559 | 8.942 | 7.313 | -1.380 | SP |
| Dec 26, 06 | 54096.292 | -1.655 | 8.975 | 7.315 | – | G2 |
| Jan 15, 07 | 54116.269 | -1.560 | 8.815 | 7.167 | -1.505 | SP |
| Feb 11, 07 | 54143.254 | -1.624 | 8.860 | 7.216 | -1.448 | SP |

Table 2 *U, B, V, R_C* observations of Z And.

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | <i>R_C</i> | Obs |
|------------|-----------|----------|----------|----------|----------------------|-----|
| Nov 8, 03 | 52952.222 | 10.612 | 11.472 | 10.414 | – | G2 |
| Dec 8, 03 | 52982.293 | 10.636 | 11.516 | 10.432 | – | G2 |
| Dec 25, 03 | 52999.275 | 10.656 | 11.478 | 10.408 | – | G2 |
| Jan 6, 04 | 53011.276 | 10.630 | 11.477 | 10.396 | – | G2 |
| Jan 12, 04 | 53017.246 | 10.769 | 11.479 | 10.383 | 9.160 | SP |
| Feb 21, 04 | 53057.229 | 10.940 | 11.710 | 10.590 | – | G2 |
| Jun 22, 04 | 53178.514 | 11.086 | 11.513 | 10.467 | 9.315 | SP |
| Aug 16, 04 | 53234.433 | 9.514 | 9.941 | 9.323 | – | G2 |
| Aug 17, 04 | 53235.477 | 9.426 | 9.888 | 9.273 | – | G2 |
| Sep 3, 04 | 53251.513 | 9.301 | 9.744 | 9.137 | 8.555 | SP |
| Sep 10, 04 | 53259.471 | 9.427 | 9.871 | 9.216 | 8.564 | SP |
| Sep 14, 04 | 53262.516 | 9.352 | 9.844 | 9.174 | 8.570 | SP |
| Sep 17, 04 | 53266.400 | 9.330 | 9.859 | 9.214 | – | G2 |
| Oct 5, 04 | 53283.505 | 9.478 | 9.989 | 9.385 | 8.717 | SP |
| Oct 6, 04 | 53285.489 | 9.425 | 9.993 | 9.339 | – | G2 |
| Oct 13, 04 | 53292.229 | 9.482 | 9.982 | 9.329 | 8.679 | SP |
| Oct 25, 04 | 53303.503 | 9.550 | 10.065 | 9.385 | 8.745 | SP |
| Nov 10, 04 | 53320.196 | 9.555 | 10.123 | 9.445 | – | G2 |
| Dec 4, 04 | 53344.388 | 9.301 | 9.899 | 9.334 | 8.662 | SP |
| Dec 21, 04 | 53361.299 | 9.335 | 9.930 | 9.348 | 8.666 | SP |
| Dec 22, 04 | 53362.249 | 9.460 | 9.993 | 9.398 | 8.682 | SP |
| Feb 6, 05 | 53408.223 | 9.828 | 10.377 | 9.725 | – | G2 |
| May 1, 05 | 53491.544 | 9.844 | 10.755 | 10.006 | – | G2 |
| May 20, 05 | 53511.492 | 9.835 | 10.757 | 9.951 | – | G2 |
| May 26, 05 | 53517.465 | 9.960 | 10.730 | 9.959 | 9.033 | SP |
| Jul 29, 05 | 53581.481 | 10.074 | 10.714 | 9.897 | – | G2 |
| Aug 20, 05 | 53603.412 | 10.211 | 10.910 | 9.982 | – | G2 |
| Sep 7, 05 | 53621.421 | 10.027 | 10.856 | 9.982 | 8.992 | SP |
| Sep 26, 05 | 53639.557 | 10.096 | 10.755 | 9.911 | 8.943 | SP |
| Oct 9, 05 | 53653.443 | 10.005 | 10.706 | 9.941 | 9.006 | SP |
| Oct 22, 05 | 53666.473 | 10.044 | 10.903 | 9.993 | 9.007 | SP |
| Oct 29, 05 | 53673.445 | 9.965 | 10.809 | 9.969 | 9.007 | SP |
| Nov 4, 05 | 53679.421 | 10.037 | 10.913 | 10.036 | 9.025 | SP |
| Nov 4, 05 | 53679.421 | 10.037 | 10.913 | 10.036 | 9.025 | SP |
| Dec 4, 05 | 53709.375 | 10.095 | 10.975 | 10.090 | 9.034 | SP |
| Jan 7, 06 | 53743.375 | 10.465 | 11.166 | 10.277 | 9.220 | SP |
| Jan 10, 06 | 53746.268 | 10.258 | 11.193 | 10.338 | – | G2 |
| Jan 17, 06 | 53753.251 | 10.378 | 11.240 | 10.412 | 9.320 | SP |
| Jan 19, 06 | 53755.243 | 10.401 | 11.278 | 10.528 | 9.342 | SP |
| Jan 27, 06 | 53763.207 | 10.375 | 11.284 | 10.460 | 9.353 | SP |
| Jan 29, 06 | 53765.269 | 10.345 | 11.141 | 10.426 | 9.346 | SP |
| Apr 8, 06 | 53833.572 | 9.857 | 10.935 | 10.288 | 9.268 | SP |
| May 12, 06 | 53867.546 | 9.716 | 10.478 | 9.876 | 9.020 | SP |
| May 22, 06 | 53877.518 | 9.556 | 10.059 | 9.529 | 8.809 | SP |
| Jun 13, 06 | 53900.493 | 9.112 | 9.481 | 9.038 | 8.504 | SP |
| Jun 26, 06 | 53912.515 | 8.718 | 9.115 | 8.784 | 8.314 | SP |
| Jul 3, 06 | 53920.453 | 8.594 | 9.132 | 8.665 | – | G2 |
| Jul 7, 06 | 53923.520 | 8.506 | 9.064 | 8.617 | 8.192 | SP |
| Jul 11, 06 | 53928.440 | 8.421 | 9.084 | 8.613 | – | G2 |
| Jul 19, 06 | 53935.522 | 8.080 | 8.960 | 8.565 | 8.109 | SP |
| Jul 19, 06 | 53936.462 | 8.065 | 8.943 | 8.576 | 8.103 | SP |
| Jul 24, 06 | 53940.525 | 8.006 | 9.000 | 8.596 | – | G2 |
| Jul 28, 06 | 53945.442 | 8.181 | 9.038 | 8.648 | 8.196 | SP |
| Aug 15, 06 | 53963.377 | 8.873 | 9.426 | 8.942 | – | G2 |
| Sep 2, 06 | 53981.347 | 8.855 | 9.385 | 8.971 | 8.421 | SP |
| Sep 9, 06 | 53988.390 | 8.938 | 9.499 | 9.065 | 8.492 | SP |

Table 2 Continued

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | <i>R_C</i> | Obs |
|------------|-----------|----------|----------|----------|----------------------|-----|
| Sep 13, 06 | 53991.528 | 9.076 | 9.584 | 9.094 | 8.494 | SP |
| Sep 14, 06 | 53993.361 | 9.072 | 9.611 | 9.092 | – | G2 |
| Sep 22, 06 | 54001.462 | 9.093 | 9.604 | 9.103 | 8.499 | SP |
| Sep 23, 06 | 54002.329 | 8.989 | 9.498 | 9.028 | 8.434 | SP |
| Sep 25, 06 | 54004.403 | 8.955 | 9.560 | 9.020 | 8.469 | SP |
| Oct 18, 06 | 54026.528 | 9.006 | 9.655 | 9.135 | 8.534 | SP |
| Oct 25, 06 | 54034.411 | 9.016 | 9.797 | 9.242 | 8.547 | SP |
| Oct 26, 06 | 54035.379 | 9.040 | 9.789 | 9.239 | 8.583 | SP |
| Nov 16, 06 | 54056.351 | 9.245 | 9.950 | 9.379 | 8.652 | SP |
| Nov 17, 06 | 54057.363 | 9.259 | 9.993 | 9.405 | 8.655 | SP |
| Nov 28, 06 | 54068.394 | 9.264 | 9.980 | 9.434 | 8.694 | SP |
| Dec 1, 06 | 54071.356 | 9.149 | 9.969 | 9.418 | 8.699 | SP |
| Dec 18, 06 | 54088.383 | 8.967 | 10.017 | 9.461 | 8.768 | SP |
| Dec 19, 06 | 54089.351 | 8.934 | 10.027 | 9.497 | 8.767 | SP |
| Dec 26, 06 | 54096.264 | 9.019 | 10.261 | 9.687 | – | G2 |
| Dec 30, 06 | 54100.270 | 9.039 | 10.090 | 9.585 | 8.837 | SP |
| Jan 15, 07 | 54116.231 | 9.219 | 10.334 | 9.741 | 8.880 | SP |
| Jan 26, 07 | 54127.217 | 9.205 | 10.495 | 9.783 | – | G2 |
| Feb 11, 07 | 54143.218 | 9.591 | 10.888 | 10.082 | 8.972 | SP |

Table 3 *B*, *V*, *R_C*, *I_C* CCD observations of Z And.

| Date | JD 24... | <i>B</i> | <i>V</i> | <i>R_C</i> | ΔI_C | Obs |
|------------|-----------|----------|----------|----------------------|--------------|-----|
| Feb 16, 03 | 52687.328 | 11.250 | 10.418 | – | – | G1 |
| Jul 19, 03 | 52840.467 | 11.492 | 10.424 | – | -1.416 | G1 |
| Sep 8, 03 | 52891.399 | 11.349 | 10.385 | – | -1.519 | G1 |
| Sep 18, 03 | 52900.581 | 11.428 | 10.380 | – | -1.568 | G1 |
| Sep 21, 03 | 52903.573 | 11.470 | 10.415 | – | -1.592 | G1 |
| Oct 12, 03 | 52925.438 | 11.450 | 10.436 | – | -1.580 | G1 |
| Oct 15, 03 | 52928.439 | 11.459 | 10.377 | – | -1.374 | G1 |
| Oct 18, 03 | 52931.383 | 11.445 | 10.371 | – | -1.392 | G1 |
| Nov 10, 03 | 52954.297 | 11.451 | 10.398 | – | -1.418 | G1 |
| Nov 21, 03 | 52965.293 | 11.438 | 10.412 | – | -1.383 | G1 |
| Dec 2, 03 | 52976.273 | 11.461 | 10.421 | – | -1.433 | G1 |
| Dec 7, 03 | 52981.330 | 11.476 | 10.431 | – | -1.421 | G1 |
| Dec 18, 03 | 52992.200 | 11.445 | 10.393 | – | -1.434 | G1 |
| Jul 22, 04 | 53208.545 | 10.404 | 9.585 | 8.718 | -1.084 | G1 |
| Aug 11, 04 | 53228.545 | 10.318 | 9.629 | 8.826 | -1.007 | G1 |
| Aug 17, 04 | 53234.609 | 9.936 | 9.307 | 8.613 | -1.117 | G1 |
| Aug 19, 04 | 53236.612 | 9.869 | 9.263 | 8.582 | -1.123 | G1 |
| Aug 20, 04 | 53237.535 | 9.909 | 9.285 | 8.594 | -1.114 | G1 |
| Aug 28, 04 | 53245.600 | 9.754 | 9.157 | 8.519 | -1.162 | G1 |
| Sep 3, 04 | 53252.291 | 9.840 | 9.179 | 8.494 | -1.188 | G1 |
| Sep 4, 04 | 53253.288 | 9.857 | 9.202 | 8.524 | -1.170 | G1 |
| Sep 6, 04 | 53255.449 | 9.796 | 9.147 | 8.591 | -1.153 | G1 |
| Sep 17, 04 | 53266.394 | 9.848 | 9.220 | 8.563 | -1.179 | G1 |
| Oct 2, 04 | 53281.301 | 10.060 | 9.390 | 8.662 | -1.103 | G1 |
| Oct 4, 04 | 53283.374 | 10.011 | 9.348 | 8.647 | -1.109 | G1 |
| Oct 5, 04 | 53284.278 | 10.035 | 9.355 | 8.639 | -1.115 | G1 |
| Oct 11, 04 | 53290.455 | 10.159 | 9.462 | 8.710 | -1.104 | G1 |
| Jan 9, 05 | 53380.239 | 10.047 | 9.478 | 8.776 | -0.994 | G1 |
| Jan 10, 05 | 53381.222 | 10.069 | 9.513 | 8.780 | -1.015 | G1 |
| Jan 11, 05 | 53382.295 | 10.119 | 9.537 | 8.829 | -0.970 | G1 |
| Jan 16, 05 | 53387.266 | 10.014 | 9.535 | 8.876 | -0.919 | G1 |
| Jan 29, 05 | 53400.213 | 10.227 | 9.626 | 8.902 | -0.926 | G1 |
| Feb 4, 05 | 53406.290 | 10.176 | 9.593 | 8.878 | -0.954 | G1 |
| Jul 20, 05 | 53572.391 | 10.606 | – | 8.982 | -0.912 | G1 |
| Aug 11, 05 | 53594.481 | 10.792 | 9.915 | 8.980 | -0.934 | G1 |
| Aug 13, 05 | 53596.486 | 10.667 | 9.853 | 8.935 | -0.864 | G1 |
| Sep 5, 05 | 53619.438 | 10.752 | 9.944 | 8.970 | -0.910 | G1 |
| Sep 8, 05 | 53622.417 | 10.747 | 9.937 | 8.977 | -0.835 | G1 |
| Oct 5, 05 | 53649.470 | 10.597 | 9.875 | 8.969 | -0.876 | G1 |
| Oct 5, 05 | 53649.488 | 10.599 | 9.893 | 8.976 | -0.913 | G1 |
| Oct 6, 05 | 53650.477 | 10.600 | 9.836 | 8.941 | -0.943 | G1 |
| Oct 8, 05 | 53652.414 | 10.739 | 9.938 | 9.019 | -0.868 | G1 |
| Oct 31, 05 | 53675.355 | 10.860 | 9.965 | 9.996 | -0.908 | G1 |
| Jan 8, 06 | 53744.286 | 11.226 | 10.255 | 9.223 | -0.748 | G1 |
| Jan 8, 06 | 53744.298 | 11.226 | 10.253 | 9.223 | -0.741 | G1 |
| Jan 25, 06 | 53761.187 | 11.264 | – | – | – | G1 |
| Jan 27, 06 | 53763.233 | 11.259 | – | – | – | G1 |
| Feb 2, 06 | 53769.227 | 11.202 | 10.428 | 9.347 | -0.680 | G1 |
| Feb 2, 06 | 53769.238 | 11.200 | 10.418 | 9.347 | -0.676 | G1 |
| Feb 3, 06 | 53770.212 | 11.187 | 10.415 | 9.329 | -0.675 | G1 |
| Feb 3, 06 | 53770.232 | 11.185 | 10.414 | 9.320 | -0.675 | G1 |
| Feb 3, 06 | 53770.253 | 11.183 | 10.411 | 9.320 | -0.687 | G1 |
| Feb 5, 06 | 53772.223 | 11.144 | 10.386 | 9.326 | -0.685 | G1 |
| Feb 5, 06 | 53772.253 | 11.156 | 10.394 | 9.326 | -0.681 | G1 |
| Sep 7, 06 | 53986.382 | 9.557 | 9.085 | 8.511 | -1.131 | G1 |
| Oct 17, 06 | 54026.229 | 9.766 | 9.262 | 8.648 | -1.068 | G1 |
| Oct 18, 06 | 54027.295 | 9.778 | 9.217 | 8.590 | -1.048 | G1 |
| Nov 8, 06 | 54048.420 | 9.928 | 9.314 | 8.633 | -1.143 | G1 |
| Nov 10, 06 | 54050.227 | 9.987 | 9.379 | 8.664 | -1.112 | G1 |
| Dec 25, 06 | 54095.270 | 10.160 | 9.599 | 8.827 | -0.957 | G1 |
| Jan 14, 07 | 54115.260 | 10.201 | 9.654 | 8.855 | -0.924 | G1 |

Table 4 *U, B, V, R_C* observations of BF Cyg.

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | ΔR_C | Obs |
|------------|-----------|----------|----------|----------|--------------|-----|
| Nov 08, 03 | 52952.247 | 12.322 | 13.152 | 12.709 | – | G2 |
| Dec 8, 03 | 52982.206 | – | 12.861 | 12.403 | – | G2 |
| Dec 25, 03 | 52999.185 | 12.281 | 12.894 | 12.422 | – | G2 |
| Mar 31, 04 | 53095.594 | 12.064 | 12.798 | 12.064 | 4.275 | SP |
| Apr 1, 04 | 53097.483 | 11.980 | 12.765 | 12.069 | 4.246 | SP |
| Jul 16, 04 | 53203.483 | – | 12.470 | 11.650 | – | R |
| Aug 17, 04 | 53235.365 | 11.146 | 12.240 | 11.706 | – | G2 |
| Sep 2, 04 | 53251.420 | 11.092 | 12.175 | 11.617 | 3.856 | SP |
| Sep 10, 04 | 53259.394 | 11.094 | 12.173 | 11.652 | 3.816 | SP |
| Sep 17, 04 | 53266.297 | 10.915 | 12.131 | 11.614 | – | G2 |
| Oct 12, 04 | 53291.308 | 10.927 | 12.034 | 11.480 | 3.759 | SP |
| Nov 18, 04 | 53328.183 | – | 12.030 | 11.360 | – | R |
| Nov 20, 04 | 53330.184 | – | 12.060 | 11.340 | – | R |
| Dec 4, 04 | 53344.232 | 11.126 | 11.964 | 11.293 | 3.577 | SP |
| Dec 9, 04 | 53349.193 | – | 12.110 | 11.290 | – | R |
| Dec 11, 04 | 53351.204 | 10.975 | 11.991 | 11.394 | – | G2 |
| Dec 21, 04 | 53361.180 | 11.267 | 12.030 | 11.338 | 3.518 | SP |
| Mar 22, 05 | 53451.606 | 10.485 | 11.525 | 11.074 | – | G2 |
| Mar 28, 05 | 53458.497 | 10.727 | 11.800 | 11.110 | 3.357 | SP |
| Apr 1, 05 | 53461.548 | 10.641 | 11.781 | 11.161 | – | G2 |
| Apr 2, 05 | 53462.543 | 10.856 | 12.003 | 11.216 | – | G2 |
| Apr 5, 05 | 53465.542 | 10.761 | 11.783 | 11.155 | 3.426 | SP |
| Apr 30, 05 | 53491.469 | 10.558 | 11.684 | 11.052 | – | G2 |
| May 20, 05 | 53511.431 | 10.810 | 11.890 | 11.328 | – | G2 |
| May 25, 05 | 53516.480 | 10.974 | 11.902 | 11.307 | 3.535 | SP |
| May 26, 05 | 53517.429 | 10.972 | 11.910 | 11.339 | 3.530 | SP |
| Jun 4, 05 | 53525.518 | 11.117 | 12.085 | 11.433 | 3.641 | SP |
| Jul 29, 05 | 53581.422 | 11.571 | 12.447 | 11.934 | – | G2 |
| Aug 20, 05 | 53603.362 | 11.436 | 12.394 | 11.989 | – | G2 |
| Sep 7, 05 | 53621.365 | 11.873 | 12.483 | 12.000 | 4.117 | SP |
| Sep 25, 05 | 53639.378 | 12.119 | 12.664 | 12.166 | 4.251 | SP |
| Oct 7, 05 | 53651.350 | – | 12.834 | 12.328 | 4.453 | SP |
| Oct 9, 05 | 53653.312 | 12.243 | 12.800 | 12.360 | 4.460 | SP |
| Oct 22, 05 | 53666.351 | 12.219 | 12.808 | 12.325 | 4.419 | SP |
| Oct 29, 05 | 53673.340 | 12.216 | 12.795 | 12.278 | 4.412 | SP |
| Oct 30, 05 | 53674.204 | – | 13.110 | 12.370 | – | R |
| Nov 4, 05 | 53679.225 | 12.260 | 12.875 | 12.380 | 4.490 | SP |
| Dec 4, 05 | 53709.183 | 12.370 | 12.880 | 12.412 | 4.527 | SP |
| Dec 19, 05 | 53724.189 | 12.276 | 12.835 | 12.343 | – | G2 |
| Jan 28, 06 | 53763.666 | 12.120 | 12.817 | 12.277 | 4.437 | SP |
| Jan 30, 06 | 53765.674 | 12.008 | 12.879 | 12.435 | 4.642 | SP |
| Apr 7, 06 | 53833.456 | 11.722 | 12.538 | 12.021 | 4.200 | SP |
| May 11, 06 | 53867.445 | 11.392 | 12.405 | 11.754 | 3.913 | SP |
| May 21, 06 | 53877.484 | 0.000 | 12.347 | 11.804 | 3.976 | SP |
| Jun 13, 06 | 53900.412 | 11.293 | 12.176 | 11.633 | 3.852 | SP |
| Jul 3, 06 | 53920.426 | 11.219 | 12.230 | 11.672 | – | G2 |
| Jul 6, 06 | 53923.375 | 11.273 | 12.237 | 11.585 | 3.770 | SP |
| Jul 18, 06 | 53935.487 | 11.171 | 12.125 | 11.425 | 3.778 | SP |
| Jul 23, 06 | 53940.489 | 10.945 | 12.098 | 11.522 | – | G2 |
| Jul 28, 06 | 53945.482 | 11.075 | 12.073 | 11.524 | 3.761 | SP |

Table 4 Continued

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | ΔR_c | Obs |
|------------|-----------|----------|----------|----------|--------------|-----|
| Aug 24, 06 | 53972.321 | 9.425 | 10.508 | 9.980 | – | G2 |
| Sep 4, 06 | 53983.327 | 9.285 | 10.503 | 9.930 | – | G2 |
| Sep 9, 06 | 53988.309 | 9.431 | 10.601 | 9.998 | 2.627 | SP |
| Sep 12, 06 | 53991.378 | 9.511 | 10.612 | 10.018 | 2.660 | SP |
| Sep 13, 06 | 53992.279 | 9.447 | 10.639 | 10.016 | – | G2 |
| Sep 14, 06 | 53993.314 | 9.474 | 10.647 | 10.012 | – | G2 |
| Sep 22, 06 | 54001.254 | 9.565 | 10.425 | 9.887 | 2.640 | SP |
| Sep 23, 06 | 54002.256 | 9.625 | 10.483 | 9.923 | 2.650 | SP |
| Sep 25, 06 | 54004.287 | 9.661 | 10.531 | 10.000 | 2.717 | SP |
| Oct 17, 06 | 54026.279 | 9.781 | 10.495 | 9.962 | 2.740 | SP |
| Oct 25, 06 | 54034.212 | 9.860 | 10.550 | 9.992 | 2.800 | SP |
| Oct 26, 06 | 54035.259 | 9.847 | 10.543 | 9.979 | 2.734 | SP |
| Nov 16, 06 | 54056.186 | 9.887 | 10.486 | 9.923 | 2.708 | SP |
| Nov 17, 06 | 54057.257 | 9.915 | 10.532 | 9.919 | 2.720 | SP |
| Nov 28, 06 | 54068.272 | 9.953 | 10.607 | 10.009 | 2.825 | SP |
| Dec 1, 06 | 54071.184 | 9.932 | 10.609 | 10.003 | 2.769 | SP |
| Dec 19, 06 | 54089.207 | 10.116 | 10.690 | 10.057 | 2.769 | SP |
| Dec 26, 06 | 54096.181 | 10.104 | 10.723 | 10.049 | – | G2 |

Table 5 *U, B, V, R_C* observations of CH Cyg.

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | ΔR_C | Obs |
|------------|-----------|----------|----------|----------|--------------|-----|
| Nov 8, 03 | 52952.277 | 10.015 | 8.928 | 7.225 | – | G2 |
| Dec 8, 03 | 52982.269 | 9.956 | 8.917 | 7.237 | – | G2 |
| Jan 6, 04 | 53011.233 | 9.923 | 8.797 | 7.141 | – | G2 |
| Jan 12, 04 | 53017.200 | 9.627 | 8.763 | 7.216 | -2.667 | SP |
| Mar 31, 04 | 53095.511 | 9.783 | 8.999 | 7.554 | -2.545 | SP |
| Apr 1, 04 | 53097.398 | 9.773 | 9.020 | 7.561 | -2.411 | SP |
| Jun 21, 04 | 53178.464 | 9.857 | 9.237 | 7.735 | -2.211 | SP |
| Jul 16, 04 | 53203.449 | – | 9.050 | 7.660 | – | R |
| Aug 11, 04 | 53229.377 | 9.613 | 9.133 | 7.623 | – | G2 |
| Sep 2, 04 | 53251.339 | 9.247 | 9.136 | 7.841 | -2.073 | SP |
| Sep 10, 04 | 53259.320 | 9.428 | 9.227 | 7.877 | -2.041 | SP |
| Sep 13, 04 | 53262.472 | 9.351 | 9.222 | 7.870 | -2.016 | SP |
| Sep 17, 04 | 53266.267 | 9.913 | 9.431 | 7.906 | – | G2 |
| Oct 4, 04 | 53283.454 | 9.791 | 9.301 | 7.781 | -2.176 | SP |
| Oct 12, 04 | 53291.325 | 9.534 | 9.140 | 7.673 | -2.218 | SP |
| Oct 24, 04 | 53303.343 | 9.320 | 8.949 | 7.535 | -2.304 | SP |
| Nov 18, 04 | 53328.169 | – | 9.160 | 7.790 | – | R |
| Nov 20, 04 | 53330.167 | – | 9.240 | 7.870 | – | R |
| Dec 4, 04 | 53344.343 | 9.882 | 9.515 | 7.997 | -2.028 | SP |
| Dec 11, 04 | 53351.179 | 9.857 | 9.383 | 7.906 | – | G2 |
| Dec 21, 04 | 53361.254 | 9.976 | 9.580 | 8.032 | -2.027 | SP |
| Feb 8, 05 | 53409.667 | 9.822 | 9.390 | 7.832 | – | G2 |
| Mar 23, 05 | 53452.580 | 9.728 | 9.250 | 7.713 | – | G2 |
| Mar 28, 05 | 53458.455 | 9.624 | 9.171 | 7.719 | -2.271 | SP |
| Apr 1, 05 | 53462.461 | 9.936 | 9.288 | 7.674 | – | G2 |
| Apr 4, 05 | 53465.476 | 9.741 | 9.284 | 7.741 | -2.220 | SP |
| Apr 30, 05 | 53491.400 | 9.989 | 9.365 | 7.733 | – | G2 |
| May 20, 05 | 53511.395 | 10.027 | 9.400 | 7.746 | – | G2 |
| May 25, 05 | 53516.428 | 9.897 | 9.342 | 7.773 | -2.191 | SP |
| May 26, 05 | 53517.389 | 9.891 | 9.316 | 7.764 | -2.186 | SP |
| Jun 3, 05 | 53525.484 | 9.888 | 9.352 | 7.801 | -2.192 | SP |
| Jul 29, 05 | 53581.347 | 9.972 | 9.201 | 7.517 | – | G2 |
| Jul 29, 05 | 53581.416 | 9.738 | 9.139 | 7.579 | -2.371 | SP |
| Aug 20, 05 | 53603.300 | 9.930 | 9.240 | 7.542 | – | G2 |
| Sep 25, 05 | 53639.455 | 9.910 | 9.272 | 7.688 | -2.207 | SP |
| Oct 7, 05 | 53651.285 | – | 9.030 | 7.474 | -2.456 | SP |
| Oct 9, 05 | 53653.266 | 9.892 | 9.095 | 7.513 | -2.417 | SP |
| Oct 22, 05 | 53666.308 | 9.664 | 9.025 | 7.440 | -2.478 | SP |
| Oct 29, 05 | 53673.292 | 9.616 | 8.998 | 7.406 | -2.510 | SP |
| Oct 30, 05 | 53674.188 | – | 8.980 | 7.510 | – | R |
| Nov 4, 05 | 53679.373 | 9.625 | 8.970 | 7.363 | -2.542 | SP |
| Dec 4, 05 | 53709.314 | 9.752 | 9.135 | 7.488 | -2.438 | SP |
| Jan 10, 06 | 53746.242 | 9.728 | 8.849 | 7.143 | – | G2 |
| Jan 12, 06 | 53747.696 | 9.558 | 8.787 | 7.184 | -2.696 | SP |
| Jan 28, 06 | 53763.595 | 9.527 | 8.967 | 7.391 | -2.553 | SP |
| Jan 30, 06 | 53765.639 | 9.551 | 8.836 | 7.251 | -2.650 | SP |
| Apr 7, 06 | 53833.407 | 9.693 | 9.019 | 7.443 | -2.508 | SP |
| May 11, 06 | 53867.409 | 9.696 | 8.896 | 7.310 | -2.597 | SP |
| Jun 8, 06 | 53895.356 | 10.480 | 9.183 | 7.548 | – | G2 |
| Jun 19, 06 | 53906.353 | 10.368 | 9.314 | 7.600 | – | G2 |
| Jun 25, 06 | 53912.433 | 10.119 | 9.252 | 7.652 | -2.258 | SP |
| Jul 3, 06 | 53920.360 | 10.365 | 9.316 | 7.602 | – | G2 |
| Jul 11, 06 | 53928.356 | 10.427 | 9.360 | 7.651 | – | G2 |
| Jul 18, 06 | 53935.422 | 10.183 | 9.352 | 7.777 | -2.147 | SP |
| Jul 23, 06 | 53940.405 | 10.438 | 9.508 | 7.835 | – | G2 |

Table 5 Continued

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | ΔR_C | Obs |
|------------|-----------|----------|----------|----------|--------------|-----|
| Jul 29, 06 | 53945.516 | 10.290 | 9.473 | 7.890 | -2.088 | SP |
| Sep 10, 06 | 53989.484 | 10.667 | 9.950 | 8.360 | -1.585 | SP |
| Sep 14, 06 | 53993.338 | 10.899 | 10.092 | 8.400 | – | G2 |
| Sep 22, 06 | 54001.346 | 10.790 | 10.116 | 8.542 | -1.406 | SP |
| Sep 25, 06 | 54004.358 | 10.650 | 10.190 | 8.612 | -1.348 | SP |
| Oct 25, 06 | 54034.327 | 11.080 | 10.641 | 9.125 | -0.857 | SP |
| Nov 16, 06 | 54056.316 | 11.301 | 10.992 | 9.539 | -0.410 | SP |
| Nov 17, 06 | 54057.220 | 11.331 | 11.022 | 9.566 | -0.393 | SP |
| Dec 1, 06 | 54071.312 | 11.105 | 11.029 | 9.597 | -0.411 | SP |
| Dec 19, 06 | 54089.281 | 11.496 | 11.219 | 9.777 | -0.322 | SP |
| Dec 26, 06 | 54096.238 | 11.583 | 11.289 | 9.694 | – | G2 |
| Jan 15, 07 | 54116.189 | 11.360 | 11.094 | 9.479 | -0.652 | SP |

Table 6 *U, B, V, R_C* observations of CI Cyg

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | ΔR_C | Obs |
|------------|-----------|----------|----------|----------|--------------|-----|
| Nov 12, 03 | 52956.191 | 12.520 | 12.599 | 11.077 | – | G2 |
| Dec 8, 03 | 52982.246 | 12.127 | 12.464 | 10.960 | – | G2 |
| Dec 25, 03 | 52999.241 | 12.368 | 12.512 | 11.032 | – | G2 |
| Jan 6, 04 | 53011.185 | 12.024 | 12.384 | 10.866 | – | G2 |
| Mar 31, 04 | 53095.551 | 11.987 | 12.129 | 10.737 | 0.826 | SP |
| Apr 2, 04 | 53097.531 | 11.873 | 12.129 | 10.737 | 0.788 | SP |
| Jul 16, 04 | 53203.469 | – | 11.830 | 10.710 | – | R |
| Aug 11, 04 | 53229.410 | 11.330 | 11.960 | 10.800 | – | G2 |
| Aug 16, 04 | 53234.378 | 11.346 | 11.911 | 10.677 | – | G2 |
| Aug 17, 04 | 53235.328 | 11.380 | 11.958 | 10.684 | – | G2 |
| Sep 2, 04 | 53251.380 | 11.402 | 11.931 | 10.638 | 0.606 | SP |
| Sep 10, 04 | 53259.358 | 11.408 | 11.928 | 10.677 | 0.680 | SP |
| Sep 17, 04 | 53266.329 | 11.406 | 11.938 | 10.718 | – | G2 |
| Oct 12, 04 | 53291.380 | 11.450 | 12.200 | 10.970 | 0.600 | SP |
| Oct 24, 04 | 53303.400 | 11.559 | 12.217 | 11.055 | 0.890 | SP |
| Nov 18, 04 | 53328.204 | – | 12.030 | 10.940 | – | R |
| Nov 20, 04 | 53330.203 | – | 12.030 | 10.930 | – | R |
| Dec 4, 04 | 53344.276 | 11.544 | 12.155 | 10.774 | 0.735 | SP |
| Dec 11, 04 | 53351.230 | 11.445 | 11.990 | 10.799 | – | G2 |
| Dec 21, 04 | 53361.218 | 11.430 | 12.124 | 10.950 | 0.810 | SP |
| Mar 21, 05 | 53450.600 | 11.470 | 11.904 | 10.578 | – | G2 |
| Mar 29, 05 | 53458.550 | 11.531 | 11.916 | 10.591 | 0.576 | SP |
| Apr 2, 05 | 53462.502 | 11.525 | 11.892 | 10.579 | – | G2 |
| May 1, 05 | 53491.512 | 11.605 | 11.923 | 10.544 | – | G2 |
| May 20, 05 | 53511.462 | 11.650 | 12.031 | 10.697 | – | G2 |
| May 26, 05 | 53516.511 | 11.695 | 12.060 | 10.745 | 0.757 | SP |
| Jul 29, 05 | 53581.378 | 11.761 | 12.146 | 10.867 | – | G2 |
| Jul 29, 05 | 53581.495 | 11.847 | 12.356 | 11.023 | 0.976 | SP |
| Aug 20, 05 | 53603.383 | 11.865 | 12.227 | 10.868 | – | G2 |
| Sep 25, 05 | 53639.420 | 12.253 | 12.484 | 11.114 | 1.105 | SP |
| Oct 9, 05 | 53653.358 | 12.179 | 12.406 | 11.003 | 0.970 | SP |
| Oct 22, 05 | 53666.396 | 12.325 | 12.400 | 11.035 | 1.056 | SP |
| Oct 29, 05 | 53673.387 | 12.232 | 12.342 | 10.950 | 0.959 | SP |
| Oct 30, 05 | 53674.231 | – | 12.310 | 11.030 | – | R |
| Nov 4, 05 | 53679.276 | 12.350 | 12.370 | 11.101 | 1.014 | SP |
| Dec 4, 05 | 53709.266 | 12.460 | 12.448 | 11.107 | 1.040 | SP |
| Jan 10, 06 | 53746.195 | 12.120 | 12.578 | 10.918 | – | G2 |
| Apr 7, 06 | 53833.499 | 12.400 | 12.895 | 11.356 | 1.213 | SP |
| May 11, 06 | 53867.479 | 12.074 | 12.182 | 10.988 | 1.003 | SP |
| Jun 25, 06 | 53912.472 | 10.611 | 11.307 | 10.221 | 0.426 | SP |
| Jul 3, 06 | 53920.390 | 10.293 | 11.181 | 10.154 | – | G2 |
| Jul 6, 06 | 53923.421 | 10.308 | 11.208 | 10.191 | 0.382 | SP |
| Jul 11, 06 | 53928.381 | 10.298 | 11.254 | 10.267 | – | G2 |
| Jul 18, 06 | 53935.457 | 10.502 | 11.364 | 10.343 | 0.470 | SP |
| Jul 19, 06 | 53936.395 | 10.550 | 11.479 | 10.406 | 0.562 | SP |
| Jul 23, 06 | 53940.443 | 10.365 | 11.280 | 10.284 | – | G2 |
| Jul 28, 06 | 53945.407 | 10.040 | 11.018 | 10.054 | 0.260 | SP |
| Aug 9, 06 | 53957.488 | 10.068 | 11.133 | 10.123 | 0.298 | SP |
| Aug 15, 06 | 53963.351 | 10.136 | 11.160 | 10.178 | – | G2 |
| Aug 24, 06 | 53972.354 | 10.087 | 11.269 | 10.270 | – | G2 |
| Sep 9, 06 | 53988.475 | 10.519 | 11.388 | 10.357 | 0.447 | SP |
| Sep 14, 06 | 53993.285 | 10.500 | 11.388 | 10.402 | – | G2 |
| Sep 22, 06 | 54001.304 | 10.569 | 11.494 | 10.487 | 0.520 | SP |
| Sep 23, 06 | 54002.290 | 10.624 | 11.509 | 10.493 | 0.501 | SP |
| Sep 25, 06 | 54004.324 | 10.589 | 11.480 | 10.475 | 0.503 | SP |
| Oct 17, 06 | 54026.342 | 10.835 | 11.545 | 10.597 | 0.572 | SP |
| Oct 25, 06 | 54034.254 | 10.820 | 11.672 | 10.585 | 0.571 | SP |
| Oct 26, 06 | 54035.298 | 10.890 | 11.644 | 10.597 | 0.568 | SP |
| Nov 16, 06 | 54056.227 | 10.947 | 11.739 | 10.728 | 0.640 | SP |
| Nov 28, 06 | 54068.311 | 11.106 | 11.814 | 10.738 | 0.597 | SP |
| Dec 1, 06 | 54071.273 | 11.084 | 11.937 | 10.901 | 0.734 | SP |
| Dec 19, 06 | 54089.246 | 11.117 | 11.883 | 10.858 | 0.734 | SP |
| Dec 26, 06 | 54096.214 | 11.053 | 11.788 | 10.756 | – | G2 |

Table 7 CCD B , V , R_C , I_C observations of CI Cyg.

| Date | JD 24... | B | V | ΔR_C | ΔI_C | Obs |
|------------|-----------|--------|--------|--------------|--------------|-----------------|
| Aug 10, 04 | 53228.325 | 12.056 | 10.675 | 0.578 | -0.937 | G1 [†] |
| Aug 29, 04 | 53247.376 | 11.967 | 10.523 | 0.748 | -0.486 | G1 [‡] |
| Sep 19, 04 | 53268.301 | 12.056 | 10.701 | 0.817 | -0.431 | G1 [‡] |
| Oct 3, 04 | 53282.421 | 12.151 | 10.870 | 0.982 | -0.396 | G1 [‡] |
| Oct 21, 04 | 53300.307 | 12.210 | 10.968 | 1.036 | -0.350 | G1 [‡] |
| Nov 4, 04 | 53314.320 | 12.155 | 10.914 | 1.027 | -0.379 | G1 [‡] |
| Sep 5, 05 | 53619.316 | 12.486 | 11.074 | 0.977 | -0.857 | G1 [†] |
| Apr 25, 06 | 53850.544 | 12.204 | 11.280 | 1.323 | -0.241 | G1 [†] |
| Jul 24, 06 | 53941.413 | 10.893 | 10.269 | 0.595 | -0.665 | G1 [†] |
| Sep 7, 06 | 53986.353 | 11.459 | 10.363 | 0.657 | -0.572 | G1 [‡] |

[†]CI Cyg - HD226107, [‡]CI Cyg - HD226041

Table 8 CCD B and V observations of V1329 Cyg from the Rozhen Observatory

| Date | JD 24... | B | V | Obs |
|------------|-----------|-------|-------|-----|
| Oct 02, 03 | 52915.371 | 13.69 | 13.00 | R |
| Jul 15, 04 | 53202.495 | 14.15 | 13.34 | R |
| Jul 16, 04 | 53203.499 | 14.15 | 13.33 | R |
| Nov 20, 04 | 53330.216 | 14.41 | 13.68 | R |
| Dec 8, 04 | 53348.199 | 14.49 | 13.78 | R |
| Dec 9, 04 | 53349.212 | 14.46 | 13.73 | R |
| Oct 30, 05 | 53674.246 | 14.36 | 13.46 | R |

Table 9 U , B , V , R_C observations of TXCVn

| Date | JD 24... | U | B | V | ΔR_C | Obs |
|------------|-----------|--------|--------|--------|--------------|-----|
| May 30, 03 | 52790.374 | 10.529 | 10.527 | 9.877 | 0.106 | SP |
| Dec 5, 03 | 52978.678 | 10.467 | 10.496 | 9.881 | 0.050 | SP |
| Dec 13, 03 | 52986.655 | 10.420 | 10.445 | 9.915 | 0.147 | SP |
| Jan 6, 04 | 53011.451 | 10.692 | 10.603 | 9.921 | – | G2 |
| Jan 15, 04 | 53019.584 | 10.526 | 10.531 | 9.877 | 0.106 | SP |
| Feb 21, 04 | 53057.322 | 10.945 | 10.698 | 10.003 | – | G2 |
| Mar 12, 04 | 53077.415 | 10.956 | 10.777 | 10.025 | 0.288 | SP |
| Mar 30, 04 | 53095.409 | 10.918 | 10.648 | 9.928 | 0.179 | SP |
| Mar 31, 04 | 53096.292 | 10.923 | 10.663 | 9.969 | 0.157 | SP |
| Apr 1, 04 | 53097.318 | 10.935 | 10.678 | 9.926 | 0.230 | SP |
| Dec 5, 04 | 53344.513 | 10.297 | 10.388 | 9.822 | 0.100 | SP |
| Dec 14, 04 | 53353.592 | 10.672 | 10.564 | 9.923 | 0.151 | SP |
| Dec 16, 04 | 53355.642 | 10.577 | 10.527 | 9.911 | 0.163 | SP |
| Dec 21, 04 | 53361.436 | 10.787 | 10.603 | 9.957 | 0.154 | SP |
| Feb 6, 05 | 53408.401 | 10.571 | 10.529 | 9.886 | – | G2 |
| Mar 15, 05 | 53445.367 | 10.667 | 10.590 | 9.886 | 0.190 | SP |
| Mar 28, 05 | 53458.394 | 10.630 | 10.580 | 9.945 | 0.177 | SP |
| Apr 1, 05 | 53462.324 | 10.646 | 10.581 | 9.939 | – | G2 |
| Apr 4, 05 | 53465.317 | 10.595 | 10.528 | 9.923 | 0.158 | SP |
| Apr 30, 05 | 53491.327 | 10.656 | 10.566 | 9.905 | – | G2 |
| May 20, 05 | 53511.341 | 10.626 | 10.566 | 9.897 | – | G2 |
| May 25, 05 | 53516.348 | 10.654 | 10.584 | 9.884 | 0.136 | SP |
| Jun 3, 05 | 53525.417 | 10.518 | 10.514 | 9.842 | 0.087 | SP |
| Oct 30, 05 | 53673.619 | 10.737 | 10.492 | 9.906 | 0.148 | SP |
| Nov 11, 05 | 53685.530 | 10.430 | 10.500 | 9.844 | 0.100 | SP |
| Jan 8, 06 | 53743.663 | 10.392 | 10.425 | 9.778 | 0.039 | SP |
| Jan 9, 06 | 53744.606 | 10.381 | 10.440 | 9.786 | 0.033 | SP |
| Jan 27, 06 | 53763.455 | 10.321 | 10.394 | 9.781 | 0.055 | SP |
| Jan 29, 06 | 53765.444 | 10.274 | 10.447 | 9.829 | 0.105 | SP |
| Apr 7, 06 | 53833.288 | 10.580 | 10.542 | 9.858 | 0.083 | SP |
| May 11, 06 | 53867.323 | 10.626 | 10.527 | 9.894 | 0.123 | SP |
| Oct 26, 06 | 54034.555 | 10.606 | 10.455 | 9.872 | -0.082 | SP |
| Nov 17, 06 | 54056.561 | 10.528 | 10.504 | 9.867 | 0.118 | SP |
| Nov 18, 06 | 54057.535 | – | 10.496 | 9.872 | 0.083 | SP |
| Dec 19, 06 | 54088.554 | 10.400 | 10.520 | 9.854 | 0.141 | SP |
| Dec 24, 06 | 54093.585 | 10.530 | 10.516 | 9.912 | 0.175 | SP |
| Jan 15, 07 | 54116.416 | 10.478 | 10.558 | 9.910 | 0.139 | SP |

Table 10 U, B, V, R_C observations of AG Dra

| Date | JD 24... | U | B | V | ΔR_C | Obs |
|------------|-----------|--------|--------|-------|--------------|-----|
| Nov 8, 03 | 52952.190 | 10.275 | 10.673 | 9.542 | – | G2 |
| Dec 5, 03 | 52978.629 | 10.677 | 10.846 | 9.648 | -0.781 | SP |
| Dec 13, 03 | 52986.601 | 10.688 | 10.883 | 9.644 | -0.759 | SP |
| Jan 15, 04 | 53019.539 | 11.200 | 11.090 | 9.780 | -0.640 | SP |
| Mar 12, 04 | 53077.481 | 11.466 | 11.207 | 9.852 | -0.598 | SP |
| Mar 30, 04 | 53095.467 | 11.285 | 11.055 | 9.731 | -0.745 | SP |
| Mar 31, 04 | 53096.332 | 11.537 | 11.117 | 9.801 | -0.557 | SP |
| Apr 1, 04 | 53097.355 | 11.398 | 11.181 | 9.821 | -0.572 | SP |
| Jun 21, 04 | 53178.420 | 10.952 | 11.044 | 9.720 | -0.685 | SP |
| Aug 18, 04 | 53235.568 | 10.673 | 11.017 | 9.750 | – | G2 |
| Sep 2, 04 | 53251.296 | 10.536 | 10.905 | 9.647 | -0.715 | SP |
| Sep 10, 04 | 53259.278 | 10.642 | 10.958 | 9.691 | -0.704 | SP |
| Sep 17, 04 | 53266.479 | 10.667 | 10.970 | 9.757 | – | G2 |
| Oct 12, 04 | 53291.229 | 10.498 | 10.835 | 9.626 | -0.793 | SP |
| Oct 24, 04 | 53303.457 | 10.785 | 10.918 | 9.606 | -0.687 | SP |
| Dec 5, 04 | 53344.559 | 10.923 | 10.948 | 9.710 | -0.708 | SP |
| Dec 14, 04 | 53353.650 | 10.900 | 10.895 | 9.641 | -0.751 | SP |
| Dec 22, 04 | 53361.513 | 10.895 | 10.920 | 9.632 | -0.744 | SP |
| Feb 6, 05 | 53408.359 | 11.281 | 11.088 | 9.766 | – | G2 |
| Mar 28, 05 | 53458.339 | 11.350 | 11.214 | 9.881 | -0.558 | SP |
| Apr 1, 05 | 53462.365 | 11.379 | 11.156 | 9.817 | – | G2 |
| Apr 4, 05 | 53465.391 | 11.466 | 11.170 | 9.818 | -0.586 | SP |
| Apr 30, 05 | 53491.363 | 11.330 | 11.199 | 9.861 | – | G2 |
| May 20, 05 | 53511.370 | 11.253 | 11.108 | 9.773 | – | G2 |
| May 25, 05 | 53516.390 | 11.259 | 11.187 | 9.814 | -0.478 | SP |
| May 26, 05 | 53517.350 | 11.247 | 11.218 | 9.798 | -0.617 | SP |
| Jun 3, 05 | 53525.448 | 11.286 | 11.168 | 9.792 | -0.615 | SP |
| Jul 29, 05 | 53581.448 | 9.411 | 10.260 | 9.319 | – | G2 |
| Jul 29, 05 | 53581.376 | 9.394 | 10.293 | 9.294 | -1.048 | SP |
| Aug 20, 05 | 53603.327 | 9.551 | 10.251 | 9.305 | – | G2 |
| Sep 7, 05 | 53621.308 | 9.540 | 10.316 | 9.346 | -1.081 | SP |
| Sep 15, 05 | 53629.363 | 9.323 | 10.194 | 9.170 | -1.214 | SP |
| Oct 6, 05 | 53650.355 | 9.601 | 10.420 | 9.418 | -1.012 | SP |
| Oct 7, 05 | 53651.233 | 9.540 | 10.343 | 9.409 | -1.053 | SP |
| Oct 9, 05 | 53653.230 | 9.541 | 10.311 | 9.367 | -1.149 | SP |
| Oct 22, 05 | 53666.276 | 9.698 | 10.495 | 9.497 | -0.960 | SP |
| Oct 29, 05 | 53673.246 | 9.784 | 10.530 | 9.522 | -0.979 | SP |
| Oct 30, 05 | 53673.666 | 9.808 | 10.495 | 9.521 | -0.987 | SP |
| Jan 8, 06 | 53743.601 | 10.775 | 10.933 | 9.707 | -0.752 | SP |
| Jan 9, 06 | 53744.561 | 10.842 | 10.983 | 9.691 | -0.774 | SP |
| Jan 17, 06 | 53753.377 | 11.015 | 10.955 | 9.697 | -0.735 | SP |
| Jan 27, 06 | 53763.395 | 10.893 | 10.978 | 9.724 | -0.732 | SP |
| Jan 29, 06 | 53765.398 | 10.948 | 10.967 | 9.683 | -0.753 | SP |
| Apr 7, 06 | 53833.324 | 10.939 | 10.988 | 9.693 | -0.773 | SP |
| May 11, 06 | 53867.376 | 10.682 | 11.016 | 9.777 | -0.694 | SP |
| Jul 4, 06 | 53921.434 | 9.970 | 10.455 | 9.275 | -1.008 | SP |
| Jul 11, 06 | 53928.410 | 9.145 | 9.689 | 9.038 | – | G2 |
| Jul 18, 06 | 53935.373 | 8.891 | 9.373 | 8.843 | -1.314 | SP |
| Jul 19, 06 | 53936.428 | 8.841 | 9.338 | 8.814 | -1.331 | SP |
| Jul 23, 06 | 53940.371 | 8.808 | 9.331 | 8.764 | – | G2 |
| Jul 28, 06 | 53945.366 | 8.539 | 9.144 | 8.642 | -1.465 | SP |
| Aug 11, 06 | 53959.491 | 8.339 | 9.103 | 8.645 | -1.514 | SP |
| Aug 15, 06 | 53963.319 | 8.225 | 9.071 | 8.596 | – | G2 |
| Sep 4, 06 | 53983.285 | 8.024 | 8.873 | 8.450 | – | G2 |
| Sep 10, 06 | 53989.320 | 8.090 | 8.858 | 8.434 | -1.657 | SP |

Table 10 Continued

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | ΔR_C | Obs |
|------------|-----------|----------|----------|----------|--------------|-----|
| Sep 12, 06 | 53991.451 | 8.137 | 8.965 | 8.514 | -1.595 | SP |
| Sep 14, 06 | 53993.258 | 7.988 | 8.921 | 8.515 | – | G2 |
| Sep 22, 06 | 54001.381 | 8.034 | 8.824 | 8.431 | -1.644 | SP |
| Sep 23, 06 | 54002.364 | 8.124 | 8.926 | 8.476 | -1.582 | SP |
| Sep 25, 06 | 54004.473 | 7.705 | 8.863 | 8.403 | -1.630 | SP |
| Sep 28, 06 | 54007.469 | 8.179 | 8.989 | 8.541 | -1.598 | SP |
| Oct 17, 06 | 54026.397 | 8.249 | 9.065 | 8.596 | -1.486 | SP |
| Oct 25, 06 | 54034.366 | 8.241 | 9.045 | 8.625 | -1.492 | SP |
| Oct 26, 06 | 54035.335 | 8.205 | 9.012 | 8.566 | -1.511 | SP |
| Nov 17, 06 | 54056.521 | 8.429 | 9.327 | 8.800 | -1.377 | SP |
| Nov 17, 06 | 54057.437 | 8.426 | 9.287 | 8.724 | -1.478 | SP |
| Dec 1, 06 | 54071.468 | 8.378 | 9.205 | 8.738 | -1.389 | SP |
| Dec 20, 06 | 54089.502 | 8.532 | 9.345 | 8.793 | -1.314 | SP |
| Dec 24, 06 | 54093.543 | 8.554 | 9.391 | 8.872 | -1.269 | SP |
| Dec 26, 06 | 54096.342 | 8.578 | 9.555 | 8.965 | – | G2 |
| Jan 15, 07 | 54116.352 | 9.084 | 9.794 | 9.223 | -0.990 | SP |
| Feb 14, 07 | 54146.466 | 9.008 | 9.804 | 9.148 | -1.071 | SP |

Table 11 CCD *B*, *V*, R_C , I_C observations of AG Dra. Indices *a* and *b* denote the used comparison stars (Sect. 4.9)

| Date | JD 24... | <i>B</i> | <i>V</i> | ΔR_C | ΔI_C | Obs |
|------------|-----------|----------|----------|--------------|--------------|-----------------|
| Mar 3, 05 | 53432.504 | 11.338 | 9.883 | -0.945 | -1.454 | G1 ^a |
| May 21, 05 | 53512.335 | 11.287 | 9.788 | -1.197 | -1.562 | G1 ^a |
| May 25, 05 | 53516.338 | 11.306 | 9.782 | -1.811 | -2.128 | G1 ^b |
| May 26, 05 | 53517.337 | 11.306 | 9.769 | -1.825 | -2.141 | G1 ^b |
| Jul 20, 05 | 53572.422 | – | – | -2.184 | -2.508 | G1 ^b |
| Jul 24, 05 | 53576.335 | 10.375 | 9.311 | -2.140 | -2.435 | G1 ^b |
| Jul 27, 05 | 53579.367 | 10.333 | 9.276 | -2.214 | -2.465 | G1 ^b |
| Aug 11, 05 | 53594.315 | 10.347 | 9.281 | -2.269 | -2.479 | G1 ^b |
| Sep 23, 05 | 53637.303 | 10.475 | 9.365 | -2.223 | -2.420 | G1 ^b |
| Jan 27, 06 | 53763.329 | 11.069 | 9.676 | -1.925 | -2.202 | G1 ^b |
| Apr 8, 06 | 53833.566 | 11.099 | 9.701 | – | -2.131 | G1 ^b |
| Apr 21, 06 | 53847.291 | 11.046 | 9.657 | -1.890 | -2.146 | G1 ^b |
| May 19, 06 | 53875.445 | 11.141 | 9.750 | -1.854 | -2.121 | G1 ^b |
| Jun 14, 06 | 53901.398 | 10.959 | 9.626 | -1.933 | -2.196 | G1 ^b |
| Jul 24, 06 | 53941.340 | 9.314 | 8.741 | -2.589 | -2.717 | G1 ^b |
| Aug 19, 06 | 53967.409 | 9.091 | 8.548 | -2.644 | -2.776 | G1 ^b |

Table 12 *B*, *V*, R_C , I_C observations of Draco C-1

| Date | JD 24... | <i>B</i> | <i>V</i> | R_C | I_C | Obs |
|------------|-----------|----------|----------|--------|--------|---------|
| Feb 17, 01 | 51957.626 | – | 17.12 | – | – | R 0.5-m |
| Mar 24, 01 | 51993.464 | 18.084 | 17.043 | 16.311 | 15.650 | R 2-m |
| Mar 05, 02 | 52339.514 | 18.695 | 17.233 | 16.475 | 15.823 | R 2-m |
| Feb 28, 03 | 52698.524 | 18.677 | 17.232 | 16.456 | 15.821 | R 2-m |
| Mar 02, 03 | 52700.515 | 18.637 | 17.185 | 16.453 | 15.827 | R 2-m |
| Mar 02, 03 | 52701.464 | 18.620 | 17.206 | 16.443 | 15.860 | R 2-m |
| Apr 02, 03 | 52732.499 | – | 17.19 | 16.33 | 15.68 | R 0.5-m |
| Mar 12, 05 | 53442.474 | 18.619 | 17.133 | 16.341 | 15.679 | R 2-m |

Table 13 *U*, *B*, *V* observations of RW Hya

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | Obs |
|------------|-----------|----------|----------|----------|------|
| Apr 22, 04 | 53118.377 | 10.401 | 10.275 | 8.802 | SAAO |
| Apr 23, 04 | 53119.362 | 10.404 | 10.279 | 8.811 | SAAO |
| Apr 26, 04 | 53122.406 | 10.427 | 10.298 | 8.829 | SAAO |
| May 02, 04 | 53128.277 | 10.370 | 10.258 | 8.805 | SAAO |

Table 14 *U, B, V* observations of SY Mus

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | Obs |
|------------|-----------|----------|----------|----------|------|
| Apr 22, 04 | 53118.304 | 11.433 | 12.045 | 10.765 | SAAO |
| Apr 22, 04 | 53118.305 | 11.434 | 12.058 | 10.762 | SAAO |
| Apr 22, 04 | 53118.308 | 11.419 | 12.055 | 10.769 | SAAO |
| Apr 22, 04 | 53118.309 | 11.425 | 12.045 | 10.763 | SAAO |
| Apr 22, 04 | 53118.317 | 11.455 | 12.124 | 10.808 | SAAO |
| Apr 22, 04 | 53118.318 | 11.439 | 12.135 | 10.816 | SAAO |
| Apr 23, 04 | 53119.339 | 11.448 | 12.048 | 10.758 | SAAO |
| Apr 23, 04 | 53119.339 | 11.429 | 12.065 | 10.751 | SAAO |
| Apr 23, 04 | 53119.340 | 11.465 | 12.064 | 10.750 | SAAO |
| Apr 23, 04 | 53119.341 | 11.464 | 12.055 | 10.760 | SAAO |
| Apr 23, 04 | 53119.346 | 11.459 | 12.050 | 10.751 | SAAO |
| Apr 23, 04 | 53119.347 | 11.453 | 12.057 | 10.750 | SAAO |

Table 15 *U, B, V* observations of AR Pav

| Date | JD 24... | <i>U</i> | <i>B</i> | <i>V</i> | Obs |
|------------|-----------|----------|----------|----------|------|
| Apr 23, 04 | 53118.549 | 11.144 | 11.710 | 11.004 | SAAO |
| Apr 23, 04 | 53118.554 | 11.147 | 11.720 | 10.995 | SAAO |
| Apr 23, 04 | 53118.557 | 11.151 | 11.729 | 10.996 | SAAO |
| Apr 24, 04 | 53119.637 | 11.213 | 11.757 | 11.015 | SAAO |
| Apr 24, 04 | 53119.637 | 11.214 | 11.742 | 11.005 | SAAO |
| Apr 24, 04 | 53119.644 | 11.167 | 11.728 | 10.994 | SAAO |
| Apr 24, 04 | 53119.645 | 11.165 | 11.720 | 10.988 | SAAO |
| Apr 27, 04 | 53122.641 | 11.196 | 11.767 | 11.038 | SAAO |
| Apr 27, 04 | 53122.647 | 11.178 | 11.742 | 11.010 | SAAO |
| May 3, 04 | 53128.657 | 11.184 | 11.793 | 11.066 | SAAO |
| May 3, 04 | 53128.662 | 11.192 | 11.765 | 11.025 | SAAO |
| Sep 7, 05 | 53621.323 | 11.805 | 12.102 | 11.455 | SAAO |
| Sep 7, 05 | 53621.329 | 11.808 | 12.157 | 11.484 | SAAO |
| Sep 7, 05 | 53621.334 | 11.804 | 12.137 | 11.480 | SAAO |
| Sep 9, 05 | 53623.299 | 11.870 | 12.187 | 11.540 | SAAO |
| Sep 9, 05 | 53623.304 | 11.924 | 12.271 | 11.619 | SAAO |

Table 16 U, B, V, R_C observations of AG Peg

| Date | JD 24... | U | B | V | ΔR_C | Obs |
|------------|-----------|--------|--------|-------|--------------|-----|
| Nov 8, 03 | 52952.301 | 9.972 | 10.154 | 8.993 | – | G2 |
| Dec 8, 03 | 52982.175 | 9.981 | 10.187 | 9.038 | – | G2 |
| Dec 25, 03 | 52999.215 | 9.922 | 10.092 | 8.901 | – | G2 |
| Jan 6, 04 | 53011.211 | 9.932 | 10.082 | 8.915 | – | G2 |
| Aug 17, 04 | 53235.449 | 8.956 | 9.638 | 8.501 | – | G2 |
| Sep 2, 04 | 53251.468 | 9.039 | 9.592 | 8.437 | -0.213 | SP |
| Sep 10, 04 | 53259.434 | 8.917 | 9.557 | 8.446 | -0.211 | SP |
| Sep 17, 04 | 53266.368 | 8.865 | 9.590 | 8.460 | – | G2 |
| Oct 24, 04 | 53303.428 | 8.775 | 9.517 | 8.366 | -0.304 | SP |
| Dec 4, 04 | 53344.311 | 8.891 | 9.502 | 8.368 | -0.281 | SP |
| Dec 11, 04 | 53351.250 | 8.781 | 9.580 | 8.440 | – | G2 |
| Dec 22, 04 | 53362.195 | 8.890 | 9.492 | 8.380 | -0.281 | SP |
| May 21, 05 | 53511.530 | 9.731 | 9.846 | 8.566 | – | G2 |
| May 27, 05 | 53517.510 | 9.817 | 9.826 | 8.571 | -0.031 | SP |
| Jul 30, 05 | 53581.509 | 9.976 | 9.987 | 8.714 | – | G2 |
| Aug 20, 05 | 53603.443 | 10.001 | 10.075 | 8.815 | – | G2 |
| Sep 25, 05 | 53639.496 | 10.258 | 10.192 | 8.921 | 0.272 | SP |
| Oct 9, 05 | 53653.404 | 10.299 | 10.265 | 9.012 | 0.372 | SP |
| Oct 22, 05 | 53666.434 | 10.297 | 10.227 | 8.976 | 0.318 | SP |
| Nov 4, 05 | 53679.316 | 10.410 | 10.237 | 8.906 | 0.306 | SP |
| Dec 4, 05 | 53709.230 | 10.298 | 10.261 | 8.979 | 0.303 | SP |
| Dec 19, 05 | 53724.225 | 10.331 | 10.289 | 8.964 | – | G2 |
| Jan 7, 06 | 53743.245 | 10.585 | 10.244 | 8.881 | 0.311 | SP |
| Jan 10, 06 | 53746.216 | 10.234 | 10.165 | 8.794 | – | G2 |
| Jan 17, 06 | 53753.193 | 10.399 | 10.136 | 8.755 | 0.151 | SP |
| Jul 3, 06 | 53920.499 | 9.309 | 9.766 | 8.529 | – | G2 |
| Jul 6, 06 | 53923.469 | 9.242 | 9.729 | 8.510 | -0.128 | SP |
| Jul 11, 06 | 53928.471 | 9.241 | 9.744 | 8.520 | – | G2 |
| Jul 19, 06 | 53935.549 | 9.281 | 9.710 | 8.496 | -0.134 | SP |
| Jul 29, 06 | 53945.556 | 9.183 | 9.627 | 8.468 | -0.115 | SP |
| Sep 10, 06 | 53989.399 | 9.136 | 9.639 | 8.479 | -0.178 | SP |
| Sep 22, 06 | 54001.424 | 9.055 | 9.636 | 8.476 | -0.180 | SP |
| Sep 25, 06 | 54004.254 | 9.071 | 9.628 | 8.465 | -0.185 | SP |
| Oct 17, 06 | 54026.468 | 8.997 | 9.590 | 8.480 | -0.180 | SP |
| Oct 25, 06 | 54034.292 | 9.039 | 9.608 | 8.492 | -0.163 | SP |
| Nov 16, 06 | 54056.276 | 8.974 | 9.588 | 8.470 | -0.190 | SP |
| Nov 17, 06 | 54057.183 | 8.994 | 9.605 | 8.508 | -0.156 | SP |
| Dec 1, 06 | 54071.227 | 9.034 | 9.651 | 8.595 | -0.092 | SP |
| Dec 19, 06 | 54089.311 | 9.086 | 9.683 | 8.574 | -0.099 | SP |
| Dec 30, 06 | 54100.205 | 9.090 | 9.722 | 8.644 | -0.057 | SP |

Table 17 U, B, V, R_C observations of AX Per.

| Date | JD 24... | U | B | V | ΔR_C | Obs |
|------------|-----------|--------|--------|--------|--------------|-----|
| Nov 8, 03 | 52952.328 | 12.849 | 13.350 | 12.027 | – | G2 |
| Dec 8, 03 | 52982.326 | 12.841 | 13.359 | 11.906 | – | G2 |
| Dec 25, 03 | 52999.312 | 13.156 | 13.234 | 11.744 | – | G2 |
| Jan 6, 04 | 53011.259 | 13.203 | 13.119 | 11.705 | – | G2 |
| Jan 14, 04 | 53019.498 | 13.108 | 13.172 | 11.733 | 3.490 | SP |
| Feb 11, 04 | 53047.206 | – | 12.970 | 11.730 | – | R |
| Feb 21, 04 | 53057.284 | 13.075 | 13.117 | 11.651 | – | G2 |
| Mar 12, 04 | 53077.327 | 13.005 | 13.020 | 11.626 | 3.421 | SP |
| Apr 1, 04 | 53097.282 | 12.960 | 12.992 | 11.537 | 3.354 | SP |
| Aug 18, 04 | 53235.531 | 11.978 | 12.640 | 11.412 | – | G2 |
| Sep 3, 04 | 53251.591 | 12.097 | 12.732 | 11.528 | 3.309 | SP |
| Sep 11, 04 | 53259.548 | 11.993 | – | 11.508 | 3.2 | SP |
| Sep 14, 04 | 53262.605 | 11.983 | 12.640 | 11.552 | 3.274 | SP |
| Sep 18, 04 | 53266.529 | 11.922 | 12.682 | 11.564 | – | G2 |
| Oct 5, 04 | 53283.614 | 11.914 | 12.426 | 11.354 | 3.127 | SP |
| Oct 25, 04 | 53303.545 | 11.892 | 12.569 | 11.495 | 3.170 | SP |
| Nov 18, 04 | 53328.389 | – | 12.490 | 11.510 | – | R |
| Nov 20, 04 | 53330.426 | – | 12.500 | 11.490 | – | R |
| Dec 4, 04 | 53344.473 | 11.838 | 12.470 | 11.327 | 3.030 | SP |
| Dec 10, 04 | 53350.328 | – | 12.390 | 11.360 | – | R |
| Dec 16, 04 | 53355.577 | – | 12.521 | 11.414 | 3.073 | SP |
| Dec 21, 04 | 53361.340 | 11.896 | 12.578 | 11.374 | 3.077 | SP |
| Feb 6, 05 | 53408.297 | 11.979 | 12.595 | 11.410 | – | G2 |
| Mar 19, 05 | 53449.287 | 12.258 | 12.681 | 11.362 | – | G2 |
| Mar 28, 05 | 53458.281 | – | – | 11.347 | 3.129 | SP |
| Apr 1, 05 | 53462.280 | 12.536 | 12.801 | 11.387 | – | G2 |
| Jul 30, 05 | 53581.541 | – | 13.161 | 11.884 | – | G2 |
| Aug 21, 05 | 53603.501 | – | – | 11.889 | – | G2 |
| Oct 10, 05 | 53653.523 | 13.003 | 13.103 | 11.746 | 3.446 | SP |
| Oct 23, 05 | 53666.555 | 13.006 | 13.246 | – | 3.680 | SP |
| Oct 30, 05 | 53673.575 | 13.150 | 13.085 | 11.733 | 3.454 | SP |
| Jan 7, 06 | 53743.486 | 12.751 | 12.845 | 11.442 | 3.221 | SP |
| Jan 9, 06 | 53744.516 | 12.790 | 12.910 | 11.408 | 3.278 | SP |
| Jan 10, 06 | 53746.295 | 12.630 | 12.836 | 11.452 | – | G2 |
| Jan 17, 06 | 53753.328 | 12.645 | 12.702 | 11.303 | 3.140 | SP |
| Jan 27, 06 | 53763.296 | 12.574 | 12.776 | 11.441 | 3.281 | SP |
| Jan 29, 06 | 53765.347 | 12.480 | 12.734 | 11.407 | 3.205 | SP |
| Apr 8, 06 | 53833.537 | 12.160 | 12.620 | 11.351 | 3.156 | SP |
| Jul 4, 06 | 53920.510 | 11.963 | 12.596 | 11.499 | – | G2 |
| Jul 5, 06 | 53921.507 | 11.999 | 12.583 | 11.474 | 3.164 | SP |
| Jul 11, 06 | 53928.498 | 11.959 | 12.647 | 11.537 | – | G2 |
| Jul 19, 06 | 53936.493 | 12.020 | 12.567 | 11.460 | 3.139 | SP |
| Sep 11, 06 | 53989.567 | 11.930 | 12.506 | 11.267 | 2.973 | SP |
| Sep 13, 06 | 53991.596 | 11.936 | 12.432 | 11.251 | 2.945 | SP |
| Sep 23, 06 | 54001.533 | 12.017 | 12.411 | 11.210 | 2.983 | SP |
| Sep 26, 06 | 54004.523 | 12.001 | 12.383 | 11.200 | 2.940 | SP |
| Oct 18, 06 | 54026.652 | 12.003 | 12.447 | 11.247 | 3.022 | SP |
| Oct 25, 06 | 54034.491 | 11.983 | 12.452 | 11.272 | 3.003 | SP |
| Nov 16, 06 | 54056.439 | 11.992 | 12.438 | 11.188 | 2.947 | SP |
| Nov 17, 06 | 54057.482 | 12.081 | 12.514 | 11.321 | 3.214 | SP |
| Dec 1, 06 | 54071.433 | 11.926 | 12.501 | 11.225 | 2.990 | SP |
| Dec 18, 06 | 54088.457 | 12.007 | 12.432 | 11.217 | 2.966 | SP |
| Dec 19, 06 | 54089.469 | 12.060 | 12.555 | 11.338 | 3.027 | SP |
| Dec 26, 06 | 54096.318 | 11.825 | 12.468 | 11.292 | – | G2 |
| Jan 15, 07 | 54116.310 | 11.972 | 12.511 | 11.297 | 3.018 | SP |
| Feb 11, 07 | 54143.315 | 12.180 | 12.660 | 11.420 | 3.098 | SP |

Table 18 *B* and *V* CCD observations of AX Per.

| Date | JD 24... | <i>B</i> | <i>V</i> | Obs |
|------------|-----------|----------|----------|-----|
| Sep 21, 03 | 52903.617 | 13.103 | 11.791 | G1 |
| Sep 21, 03 | 52903.640 | 13.093 | 11.805 | G1 |
| Oct 12, 03 | 52925.472 | 13.290 | 11.949 | G1 |
| Dec 2, 03 | 52976.292 | 13.246 | 11.788 | G1 |
| Dec 8, 03 | 52982.376 | 13.253 | 11.677 | G1 |
| Aug 9, 04 | 53226.589 | 12.601 | 11.462 | G1 |
| Aug 20, 04 | 53237.579 | 12.555 | 11.386 | G1 |
| Aug 20, 04 | 53237.595 | 12.552 | 11.390 | G1 |
| Aug 30, 04 | 53247.509 | 12.584 | 11.423 | G1 |
| Sep 19, 04 | 53268.393 | 12.594 | 11.502 | G1 |
| Oct 6, 04 | 53284.539 | 12.534 | 11.472 | G1 |
| Oct 11, 04 | 53290.479 | 12.534 | 11.507 | G1 |
| Oct 21, 04 | 53300.404 | 12.550 | 11.561 | G1 |
| Nov 4, 04 | 53314.375 | 12.498 | 11.467 | G1 |
| Dec 5, 04 | 53345.177 | 12.437 | 11.353 | G1 |
| Dec 22, 04 | 53362.166 | 12.517 | 11.499 | G1 |
| Jan 10, 05 | 53381.349 | 12.475 | 11.341 | G1 |
| Jan 16, 05 | 53387.283 | 12.419 | – | G1 |
| Feb 4, 05 | 53406.259 | 12.556 | 11.434 | G1 |
| Mar 3, 05 | 53433.235 | 12.566 | 11.328 | G1 |
| Jul 20, 05 | 53572.448 | 13.198 | 11.892 | G1 |
| Aug 12, 05 | 53594.510 | 13.252 | 12.041 | G1 |
| Aug 14, 05 | 53596.509 | 13.238 | 12.022 | G1 |
| Sep 6, 05 | 53619.529 | 13.160 | 11.890 | G1 |
| Sep 8, 05 | 53622.444 | 13.156 | 11.855 | G1 |
| Oct 5, 05 | 53648.580 | 13.107 | 11.701 | G1 |
| Oct 5, 05 | 53648.616 | 13.114 | 11.707 | G1 |
| Oct 7, 05 | 53650.508 | 13.106 | 11.695 | G1 |
| Dec 19, 05 | 53724.303 | 12.894 | 11.508 | G1 |
| Jan 27, 06 | 53763.302 | 12.735 | 11.377 | G1 |
| Feb 2, 06 | 53769.264 | 12.754 | 11.449 | G1 |