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Long-term monitoring of active stars. V. $UBV(RI)_c$ photometry collected in Feb.-Mar. 1990*

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Abstract. — High-precision *UBV(RI)*$_c$ photometry of 12 selected active stars, collected at the European Southern Observatory (La Silla, Chile) over the period February - March 1990, is presented. Significant evolution of the light curves, period variations and, in most cases, evidence for long-term variability of the global degree of spottedness are found. Some of the spectral classifications are discussed. This paper is part of a more extensive program focusing on the global properties and evolution of active stars and is aimed at establishing a time-extended photometric database which can give important clues on topics such as the stability of the spotted areas, differential rotation and solar-like cycles.

Key words: stars: activity — stars: late-type — stars: variables

1. Introduction

The optical variability observed for the RS CVn and BY Dra-type active stars is generally accounted for by the presence of huge photospheric inhomogeneities, such as cool starspots, whose visibility, modulated by the stellar rotation, produces periodic or quasi-periodic low-amplitude light variation (cf. Rodonò 1986, 1992a,b and references therein). The typical values of the peak-to-peak *V*-band variations are of the order of 0.1−0.2 magnitudes, although remarkable amplitudes up to 0.5−0.6 magnitudes have been observed (Byrne 1986; Cutispoto et al. 1987; Nolthenius 1991). The color variations usually indicate a reddening of the star at the maximum spot visibility, thus supporting the cool starspot hypothesis. However, although the $U-B$ and $B-V$ color variations are in most cases either absent or in phase with the *V*-band light curve, anticorrelation has been observed for some stars, i.e. V711 Tau, TW Lep and UX Ari (Cutispoto 1992; Rodonò & Cutispoto 1992). The orbital or photometric periods of RS CVn and BY Dra-type systems span from a few days to several weeks. The photometric wave undergoes noticeable changes, that can occur over time scales as short as a few stellar rotations (cf. Figs. 12, 18 and 23 in Cutispoto 1995); hence, in order to investigate the physical characteristics and evolution of spotted areas and the time scale of activity cycles, active stars must be observed systematically. This continuous monitoring program, already started at Catania Astrophysical Observatory in the early Sixties, is actually carried out by using the 0.5 and 1.0 m telescopes of the European Southern Observatory (ESO, La Silla, Chile), the 0.25 m Automatic Photoelectric Telescope of Franklin & Marshall College on Mt. Hopkins (AZ, U.S.A.) and the 0.8 m Automatic Photoelectric Telescope of Catania Astrophysical Observatory on Mt. Etna (Italy). It is aimed to establish the time-extended database that is essential to investigate fundamental topics such as the evolution of spotted areas and the correlation between inhomogeneities at different atmospheric levels (Rodonò et al. 1987; Pagano et al. 1992, 1993; Pallavicini et al. 1993). Long-term studies are also needed in order to search for the presence of differential rotation (Rodonò 1992a) and of photospheric solar-like activity cycles (Cutispoto & Rodonò 1992). This paper reports on the results obtained by using the 0.5 m ESO telescope and is organized as follows: details on the equipment, observations and reduction procedures are given in Sect. 2, the results and discussion on individual stars are presented in Sect. 3.

2. The observations

The present observations were carried out over the period 27 February - 11 March 1990 at the European Southern Observatory (La Silla, Chile), by using the 0.5 m ESO

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*based on data collected at the European Southern Observatory, La Silla, Chile (data available at the CDS via anonymous ftp 130.79.128.5

telescope equipped with a single-channel photon-counting photometer, a thermoelectrically cooled Hamamatzu R-943/02 photomultiplier and standard ESO filters matching the *UBV(RI)*$_c$ system. In order to obtain accurate differential photometry, for each program star (v) a comparison (c) and a check (ck) star having similar colors and magnitude were also observed (see Table 1). Each measurement consisted of the average of 10−15 1-s integrations in each filter, according to the color sequence $U - B - V - R - I$. A complete observation consisted of sequential $c - v - v - v - ck - c$ measurements. From these data, three $v - c$ and one $ck - c$ differential magnitudes were computed; the three $v - c$ values were finally averaged to obtain one data point. The observations were corrected for atmospheric extinction and transformed to the standard *UBV(RI)*$_c$ system. The atmospheric extinction coefficients were obtained during clear nights by observing two standards of very different spectral type in the 1−2.5 air mass range, while transformation coefficients were inferred by observing E-region standard stars (Menzies et al. 1989). The mean values of the extinction coefficients for La Silla are reported in Table 2. Note that these values have been obtained about one year before the eruption of Mt. Pinatubo. The typical error of the differential photometry is of the order of 0.005 magnitudes, with somewhat larger values in the *U*-band for the fainter objects due to the low photon counting level. In Table 3 the brighest *V* magnitude and corresponding colors obtained for the program stars, and the standard deviations (σ) for the mean $v - c$ and $ck - c$ differential *V*-band magnitudes obtained over *N* nights are reported. Taking into account the accuracy of the standard star data and extinction and transformation errors, the typical accuracy of the data in Table 3 results of the order of 0.01 magnitude, since they were obtained from the magnitudes and colors of the comparison and check stars, derived via standard stars (Landolt 1983; Menzies et al. 1989; Menzies & Laing 1988). Finally, the *V* magnitudes and colors of all comparison and check stars are given in Table 4. The complete data set can be obtained from the author upon request.

3. Results

Apart from the investigation on the light curve evolution with respect to previous observations, the present multicolor photometry have been used to infer, or further constrain, the spectral type and luminosity class of the program stars. Details on the method adopted can be found in Cutispoto et al. (1996). The most likely spectral types and luminosity classes derived for the program stars are given in Table 3. The results on the individual stars are discussed below.

HD 26354 = AG Dor is a SB2 system with an orbital period of 2.562 days (Balona 1987; Washüttl & Strassmeier 1995) that has been studied by several

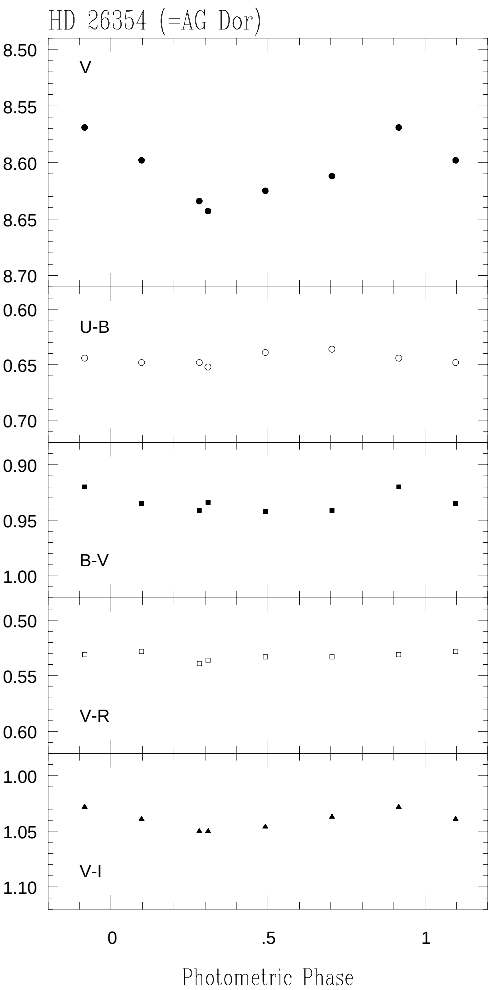

Fig. 1. *V*-band light curve and colors of HD 26354 = AG Dor. Phases are reckoned from the photometric ephemeris HJD = 2447587.52 + 2.533 · *E* (Lloyd-Evans & Koen 1987)

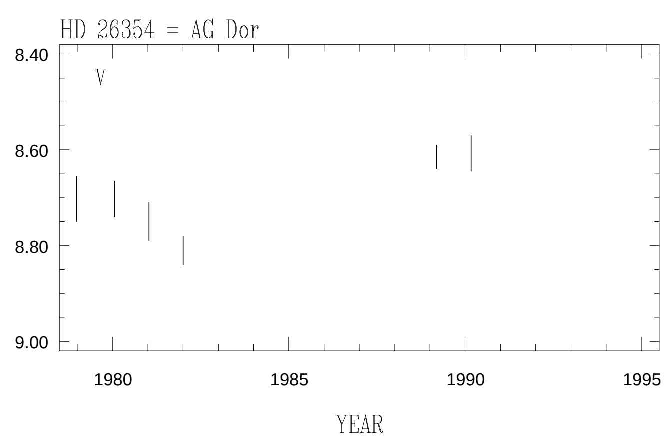

Fig. 2. *V* light long-term variability of HD 26354 = AG Dor. The vertical bars indicate the peak-to-peak amplitudes of the light curve

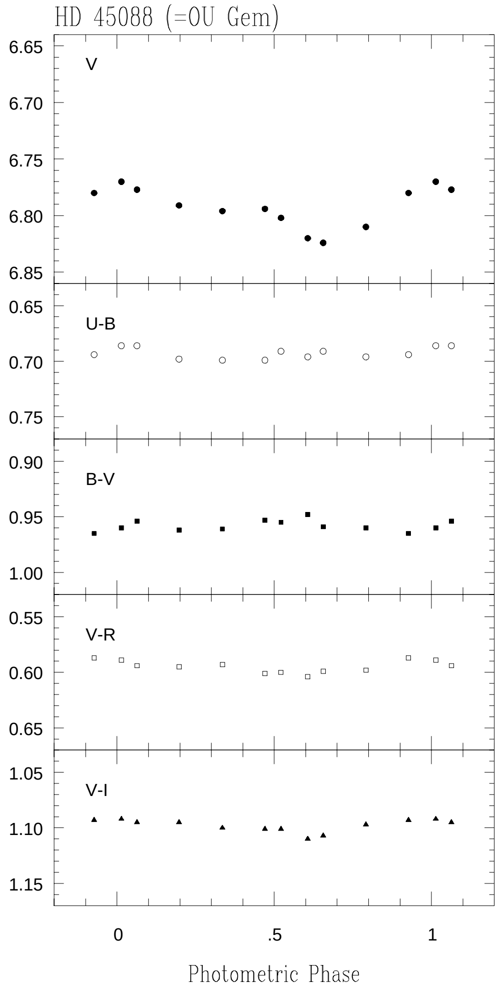

Fig. 3. V-band light curve and colors of HD 45088 = OU Gem. Phases are reckoned from the photometric ephemeris HJD = 2443846.2 + 7.36 $\cdot$ E (Bopp et al. 1981)

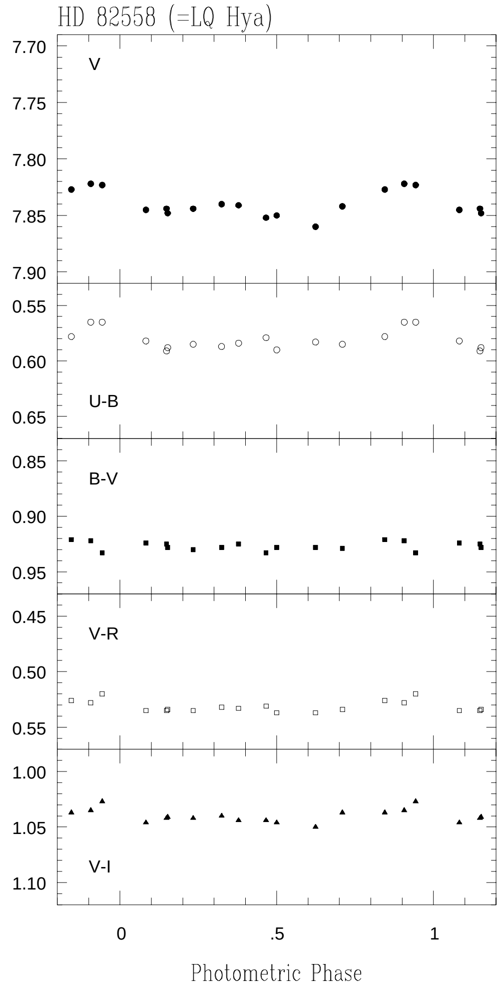

Fig. 4. V-band light curve and colors of HD 82558 = LQ Hya. Phases are reckoned from the photometric ephemeris HJD = 2445275.993 + 1.6092 $\cdot$ E

authors (see Cutispoto 1992 and references therein). The V-band and color variations obtained over the interval 27 Feb. - 5 Mar. are shown in Fig. 1, where phases are reckoned from the photometric ephemeris HJD = 2447587.52 + 2.533$\cdot E$ (Lloyd Evans & Koen 1987). The V-band light curve appears to be single-peaked with an amplitude of about 0.075 magnitudes; weak color variations are present. HD 26354 shows evidence for a long-term variability of the global degree of spottedness, as can be inferred from the photometric data shown in Fig. 2. In particular, from the present data the star appears brighter, at light maximum, than in any previous epoch. This figure and the others of this paper showing the magnitude range vs. time (i.e. Figs. 7, 10, 12, 14 and 17) present both the data from our long-term program and those available in the SIMBAD database. The spectral classification of HD 26354 is given as K1/2 V + K6 V by Cutispoto (1992), that matched the observed colors by assuming an early-K dwarf primary component according to the K1Vp classification reported by Houk (1978). On the other hand, Randich et al. (1993) report a low Li abundance and a v sin i of 20 km s^{-1} that leads to a minimum radius of about 1.0 $R_\odot$ for the primary component. This value is too high for a K-type dwarf and implies that a class IV primary component is present. In fact, the observed colors can be fairly well matched by assuming a system formed by K1 IV and G5 V components. The secondary star of such a system would be about 2 magnitudes fainter in the V-band than the primary. However, from an extensive high resolution spectroscopic study, Washüttl & Strassmeier (1995) computed v sin i of 17 $\pm$ 2 and 10 $\pm$ 5 km s^{-1} for the primary and secondary components, respectively. These values result in mimimum radii of 0.86 $R_\odot$ and 0.50 $R_\odot$ for the two components, thus weakening the subgiant hypothesis mentioned above. A very good fit of the AG Dor colors reported in Table 3 is obtained by assuming a system formed by K1 V and K5 V components. The secondary star of such a system would be about 1.2 magnitudes fainter in

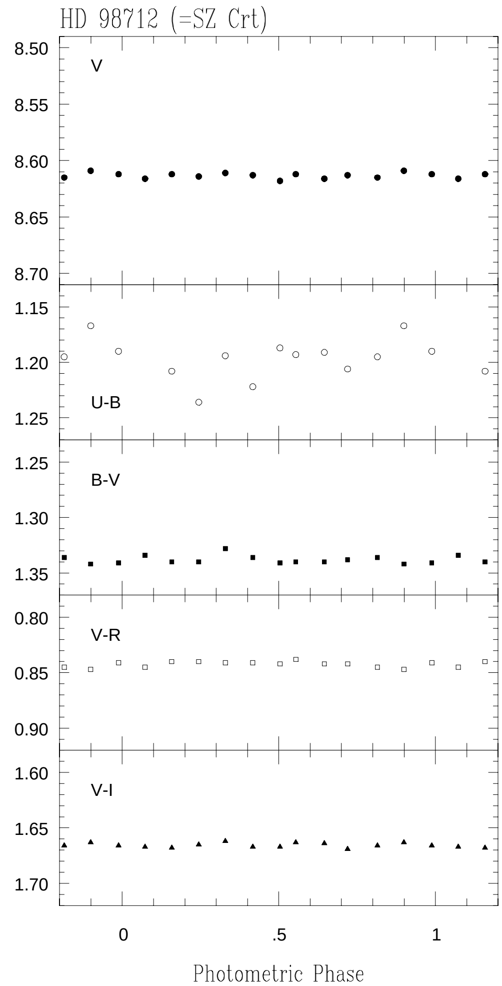

Fig. 5. *V*-band light curve and colors of HD 98712 = SZ Crt. Phases are reckoned from the photometric ephemeris HJD = 2441389.0 + 11.58 $\cdot$ E (Torres et al. 1985)

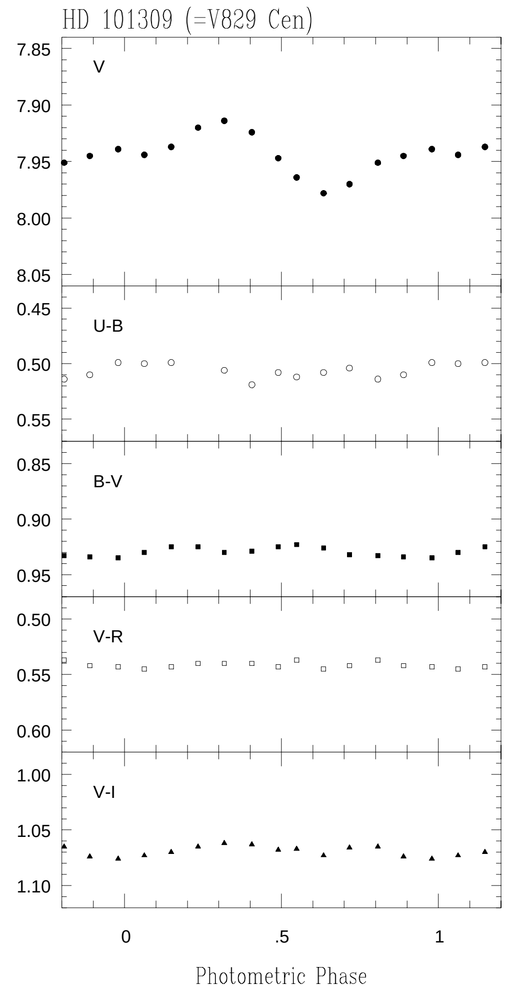

Fig. 6. *V*-band light curve and colors of HD 101309 = V829 Cen. Phases are reckoned from the photometric ephemeris HJD = 2447570.53 + 11.65 $\cdot$ E (Cutispoto 1993)

the *V*-bad than the primary. It is likely that AG Dor belongs to the BY Dra-type systems.

HD 45088 = OU Gem is a SB2 system with an orbital period of 6.99 days and a noticeable eccentricity (Griffin & Emerson 1975). Both components show Ca II H&K emission, while the Hα line is in absorption in the primary and filled in the secondary (Bopp 1980). HD 45088 was detected by the WFC on board the ROSAT satellite during the all-sky survey (Pounds et al. 1993; Pye et al. 1995) and was listed as a possible member of the UMa group by Soderblom et al. (1993). The photometric variability was discovered by Bopp et al. (1981), further observations have been carried out by Cutispoto (1991; 1992) and Rodonò & Cutispoto (1992). The present data, collected over the interval 27 Feb. - 10 Mar., are shown in Fig. 3, where phases are reckoned from the photometric period of 7.36 days computed by Bopp et al. (1981). The light curve is double-peaked and weak color variations are evident for

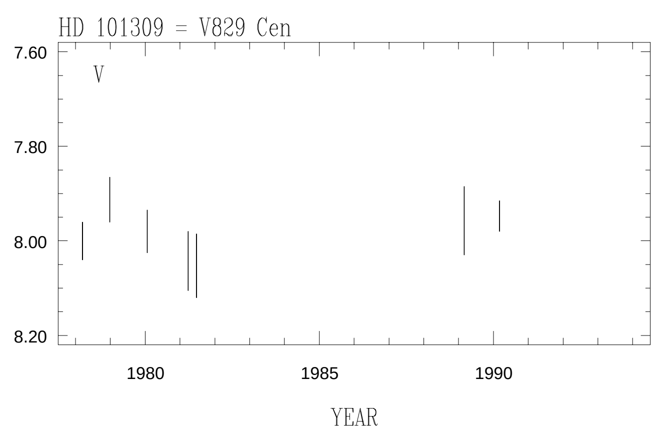

Fig. 7. *V* light long-term variability of HD 101309 = V829 Cen. The vertical bars indicate the peak-to-peak amplitudes of the light curve

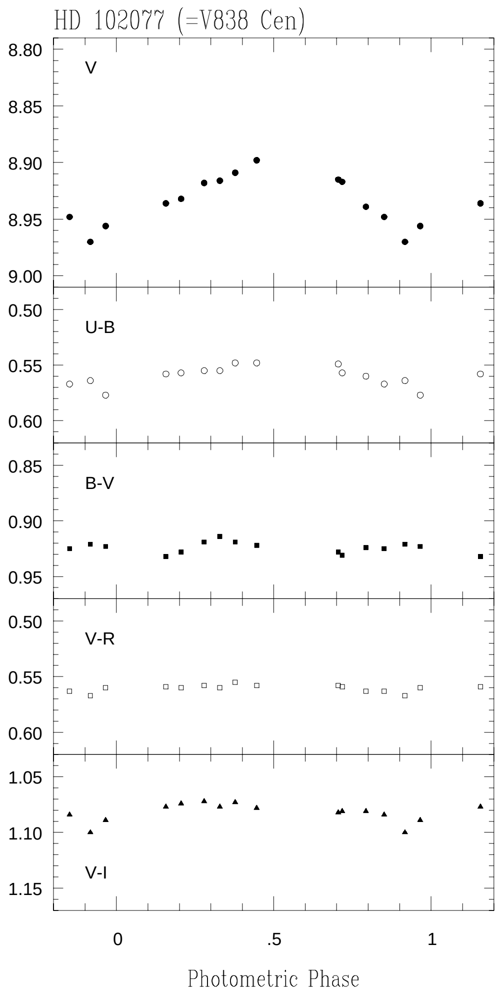

Fig. 8. V-band light curve and colors of HD 102077 = V838 Cen. Phases are reckoned from the photometric ephemeris HJD = 2445805.4 + 1.88 $\cdot$ E

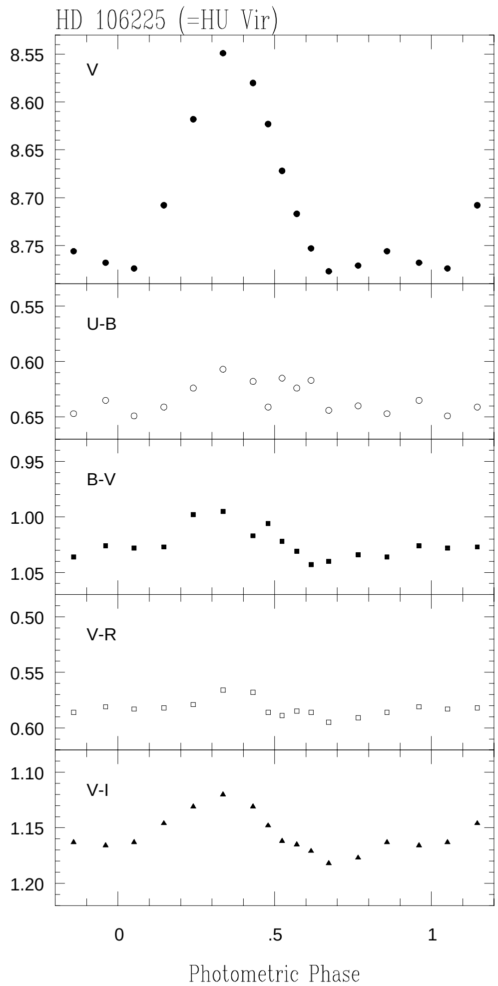

Fig. 9. V-band light curve and colors of HD 106225 = HU Vir. Phases are reckoned from the photometric ephemeris HJD = 2445214.7 + 10.50 $\cdot$ E

the V-R and V-I indices. The present observations contribute to the monitoring of HD 45088 during a period of remarkable evolution of the spotted regions (Rodonò & Cutispoto 1992). The colors are consistent with the K2 V + K5 V spectral classification reported by Bopp (1980).

HD 82558 = LQ Hya is a very active rapidly rotating BY Dra-type single star that shows very strong Ca II H&K emission lines (Strassmeier et al. 1990) and variable Hα emission (Vilhu et al. 1991). Its spectral classification is given as K2 V by Fekel et al. (1986a). Due to the observed very high Li abundance HD 82558 has been classified as a very young (Fekel et al. 1986a) or even as a PMS (Vilhu et al. 1991) star. It has been detected at EUV wavelengths by the ROSAT (Pounds et al. 1993; Pye et al. 1995) and EUVE (Malina et al. 1994) satellites. Photometric observations have been obtained by several authors (see Jetsu 1993 and references therein; Strassmeier et al. 1993a; Cutispoto 1993). The data

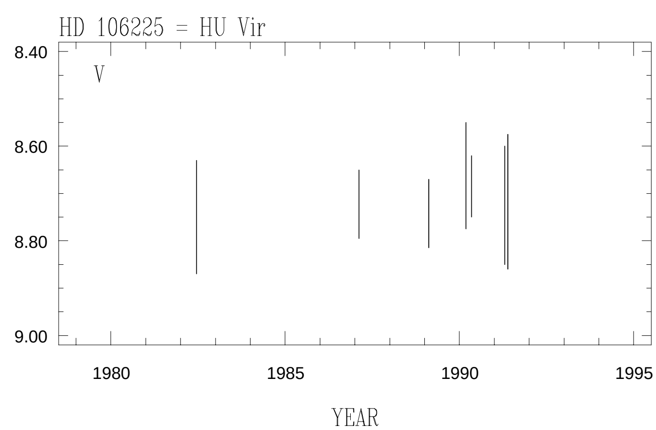

Fig. 10. V light long-term variability of HD 106225 = HU Vir. The vertical bars indicate the peak-to-peak amplitudes of the light curve

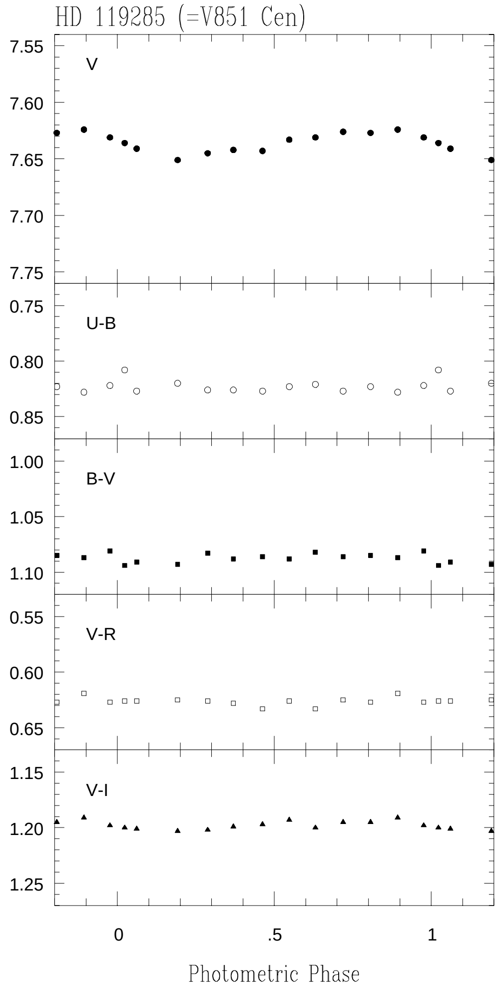

Fig. 11. *V*-band light curve and colors of HD 119285 = V851 Cen. Phases are reckoned from the photometric ephemeris HJD = 2447949.5 + 11.50 · *E*

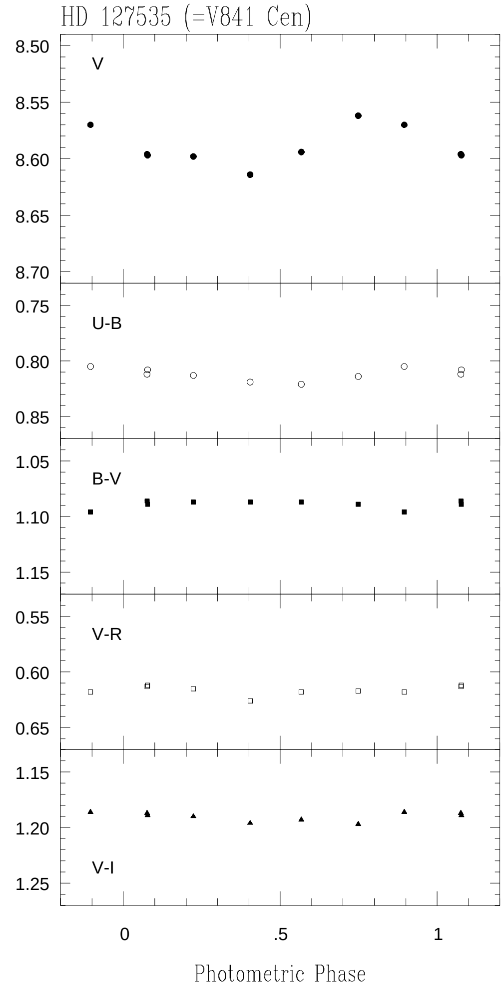

Fig. 13. *V*-band light curve and colors of HD 127535 = V841 Cen. Phases are reckoned from the photometric ephemeris HJD = 2445804.1 + 5.929 · *E* (Cutispoto 1990)

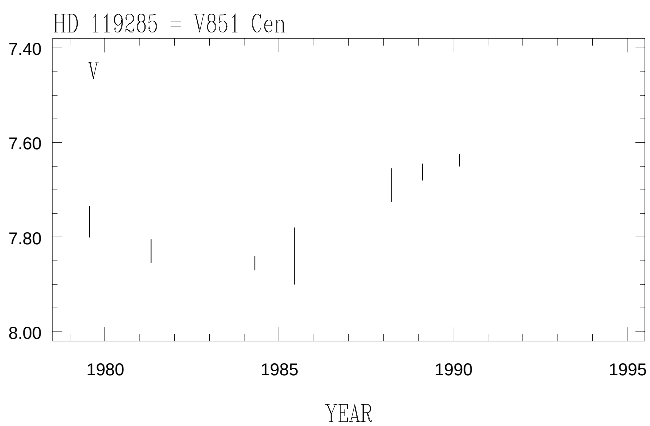

Fig. 12. *V* light long-term variability of HD 119285 = V851 Cen. The vertical bars indicate the peak-to-peak amplitudes of the light curve

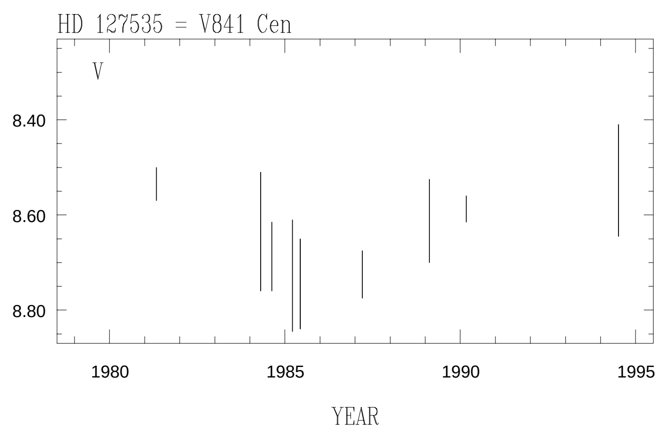

Fig. 14. *V* light long-term variability of HD 127535 = V841 Cen. The vertical bars indicate the peak-to-peak amplitudes of the light curve

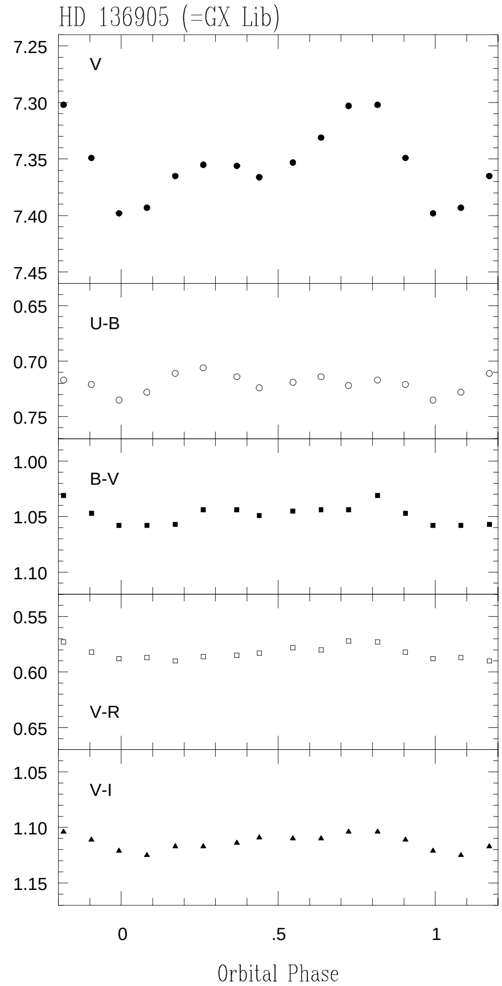

Fig. 15. V-band light curve and colors of HD 136905 = GX Lib. Phases are reckoned from the spectroscopic ephemeris HJD = 2445061.901 + 11.13448 · E (Kaye et al. 1995)

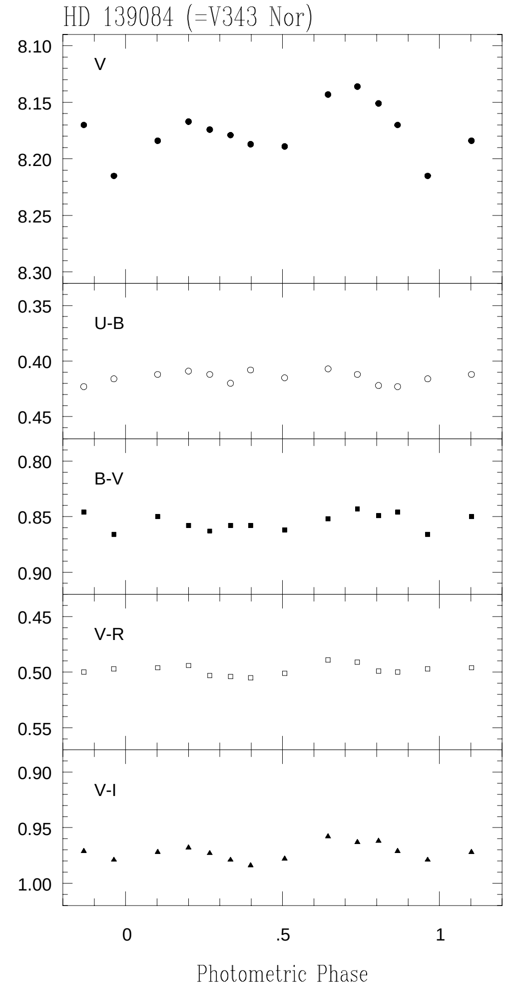

Fig. 16. V-band light curve and colors of HD 139084 = V343 Nor. Phases are reckoned from the photometric ephemeris HJD = 2445801.9 + 4.25 · E

obtained over the interval 27 Feb. - 11 Mar. are shown in Fig. 4. Phases are reckoned from the photometric ephemeris HJD = 2445275.993 + 1.6092 · E, where the initial epoch is from Fekel et al. (1986a) and the 1.6092 ± 0.0008 day period is from Strassmeier (1996). The low amplitude light curve appears double-peaked and weak color variations are detectable. The $B-V$ and $V-R$ colors agree well with the K2 V classification, while the $U-B$ and the $V-I$ are too blue and too red, respectively.

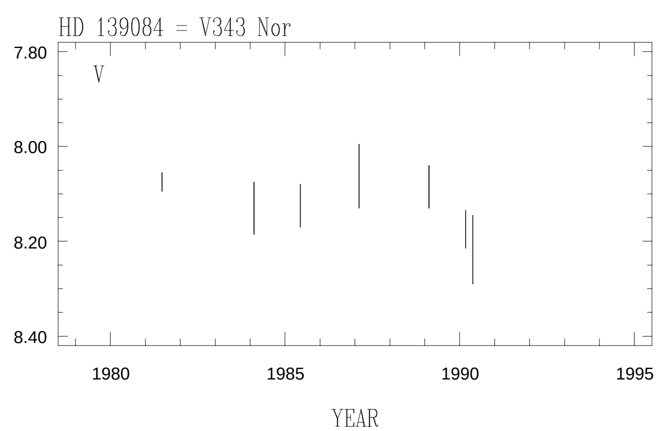

Fig. 17. V light long-term variability of HD 139084 = V343 Nor. The vertical bars indicate the peak-to-peak amplitudes of the light curve

HD 98712 = SZ Crt = GL 425 AB is the visual binary ADS 8138 and has been classified as a *marginal* BY Dra-type system by Bopp (1987). The Hα line appears highly variable and exibits strong emission in the spectra of the primary and secondary component, respectively (Torres et al. 1985; Bopp 1987). The presence of optical variability with a period of 11.58 days was first reported by Torres et al. (1985) and later confirmed by Cutispoto

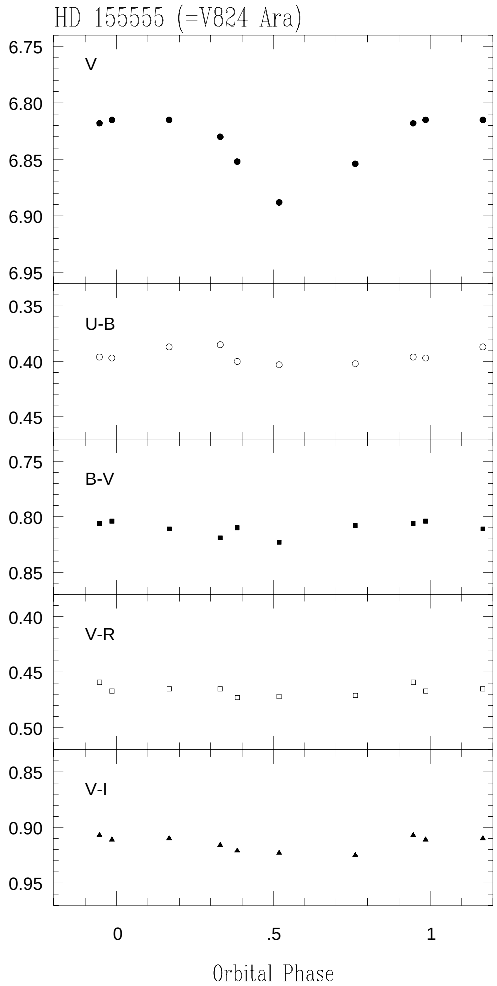

Fig. 18. V-band light curve and colors of HD 155555 = V824 Ara. Phases are reckoned from the spectroscopic ephemeris HJD = 2445803.07 + 1.681652 $\cdot$ E (Pasquini et al. 1991)

(1993). The present observations were carried out over the interval 27 Feb. - 10 Mar. and are shown in Fig. 5, where phases are reckoned from the photometric ephemeris HJD = 2441389.0 + 11.58$\cdot E$ (Torres et al. 1985). Both components were included in the diaphragm. The light curve appears flat and the maximum luminosity, V=8.61, is the same observed about one year earlier (Cutispoto 1993). Since the same value for the V magnitude was also obtained by Bessel (1990), it is likely that it corresponds to the unspotted luminosity level of HD 98712. The mean colors agree very well with the K7 V + M3 V spectral classification reported by Bidelman (1985).

HD 101309 = V829 Cen is a RS CVn-type SB2 binary with an orbital period of 11.71 days (Balona 1987), that shows Ca II H&K and Hα emission lines (Collier et al. 1982) and has been detected during a microwave survey of active stars (Slee et al. 1987). Collier et al. (1982) list the spectral classification K1 IV + G5 V; the presence of a rather high Li abundance in both components has been reported by Randich et al. (1993). The optical variability was discovered by Lloyd Evans & Koen (1987) and confirmed by Collier Cameron (1987) and by Cutispoto (1993). The present observations were collected over the interval 27 Feb. - 10 Mar. and are shown in Fig. 6, where phases have been computed by using a photometric period of 11.65 days (Cutispoto 1993). The light curve is double-peaked and the weak $U-B$ and $B-V$ colors appear anticorrelated with the V-band modulation. The $V-R$ color is almost flat while the $V-I$ color is partially correlated with the V-band variations. When compared with the observations obtained about one year earlier (Cutispoto 1993), the present data are indicative of remarkable modifications of the spotted areas, as further confirmed by the collection of the available photometric data shown in Fig. 7. From the value of v sin i computed by Randich et al. (1993) the minimum radius of the cooler primary component results in the range 4.56−4.63 $R_{\odot}$, in agreement with the presence of a luminosity class IV primary and a rather high value for the inclination "i". The $B-V$ and $V-R$ colors agree well with the K1 IV + G5 V spectral classifications inferred by Collier et al. (1982), while the $U-B$ and the $V-I$ appears too blue and too red, respectively.

Table 1. Comparison (c) and check (ck) stars used for each program star

Program Star (v)		(c)	(ck)
HD 26354	= AG Dor	HD 26779	HD 25901
HD 45088	= OU Gem	HD 45089	HD 44234
HD 82558	= LQ Hya	HD 82508	HD 82477
HD 98712	= SZ Crt	HD 97977	HD 98251
HD 101309	= V829 Cen	HD 101679	HD 101215
HD 102077	= V838 Cen	HD 102076	HD 102202
HD 106225	= HU Vir	HD 106270	HD 105796
HD 119285	= V851 Cen	HD 119164	HD 119076
HD 127535	= V841 Cen	HD 128227	HD 128618
HD 136905	= GX Lib	HD 136480	HD 137241
HD 139084	= V343 Nor	HD 139070	HD 138363
HD 155555	= V824 Ara	HD 156427	HD 154775

Table 2. Mean atmospheric extinction coefficients for La Silla site, obtained over the period 27 Feb. - 11 Mar. 1990

	U	B	V	R	I
Mag/airmass	.459	.235	.139	.099	.053

HD 102077 = V838 Cen is a close visual binary (Rossiter 3558 AB) consisting of two almost identical components separated by about 0.2 arcsec (Jeffers et al. 1963; Worley 1972; McAlister et al. 1990). The system belongs to the Pleiades group (Anders et al. 1991). It shows

Table 3. Maximum luminosity (V_{max}) and corresponding colors for the program stars; standard deviations (σ) for the $v-c$ and $ck-c$ V-band differential magnitudes for each series of N nights; inferred spectral classification (Spectral Type)

Program Star	V_{max}	U-B	B-V	V-R_c	V-I_c	σ $(v-c)$	σ $(ck-c)$	N	Spectral Type
HD 26354	8.57	0.64	0.92	0.53	1.03	25	4	6	K1 V + K5 V
HD 45088	6.77	0.69	0.95	0.59	1.09	17	5	10	K2 V + K5 V
HD 82558	7.82	0.56	0.92	0.52	1.03	11	3	11	K2 V
HD 98712	8.61	1.17	1.33	0.84	1.66	2	4	12	K7 V + M3 V
HD 101309	7.91	0.51	0.93	0.54	1.06	19	4	12	K1 IV + G5 V
HD 102077	8.90	0.55	0.92	0.56	1.07	20	3	13	K1 V + K2 V
HD 106225	8.55	0.61	1.00	0.57	1.12	77	4	13	K1 IV + ?
HD 119285	7.62	0.82	1.08	0.62	1.19	8	4	12	K2 IVe + ?
HD 127535	8.56	0.81	1.09	0.61	1.18	17	4	7	K2 IVe + ?
HD 136905	7.30	0.71	1.03	0.57	1.10	29	4	11	K1 III + G5 IV
HD 139084	8.14	0.41	0.84	0.49	0.96	22	3	11	K0 IV/V
HD 155555	6.81	0.39	0.81	0.46	0.91	25	6	7	K0 IV + G5 IV

moderate Ca II H&K emission lines and a filled-in Hα line (Bopp et al. 1986). Its photometric variability was first reported by Udalski & Geyer (1985a), and further photometric data have been collected by Bopp et al. (1986) and by Cutispoto (1990, 1993). The present observations, obtained over the interval 28 Feb. - 11 Mar., are shown in Fig. 8. The phases have been computed by using the 1.88 ± 0.03 day photometric period inferred from a Fourier analysis of the *VRI* data. The light curve, though incomplete, seems single-peaked, while the weak color variations show the star to be redder at light minimum. From the $v \sin i$ value computed by Randich et al. (1993) and the published photometric periods, the minimum stellar radius is in the range 0.73−0.85 $R_\odot$, in agreement with a luminosity class V or V/IV. In fact, Houk (1978) lists a K0/1Vp spectral type for the composite spectrum of the two components and our observed colors can be roughly fitted by assuming a K1 V + K2 V or a K0 V/IV + K1 V/IV classification.

Table 4. V magnitude and colors for the c and ck stars derived via standard stars. Errors are of the order of 0.01 magnitudes. The symbol ":" denotes errors of the order of 0.02 magnitudes

c or ck	V	U-B	B-V	V-R_c	V-I_c
HD 25901	8.85	-.01	0.04	0.00	0.01
HD 26779	8.58	1.25	1.24	0.63	1.19
HD 44234	6.30	0.92	1.08	0.54	0.98
HD 45089	7.14	1.22	1.20	0.63	1.15
HD 82477	6.13	1.18	1.19	0.61	1.18
HD 82508	7.58	0.35	0.72	0.40	0.80
HD 97977	8.84	1.67:	1.42	0.75	1.42
HD 98251	9.20	1.49:	1.31	0.69	1.29
HD 101215	7.79	0.09:	0.14	0.11	0.21
HD 101679	8.11	0.82:	1.09	0.59	1.15
HD 102076	7.11	0.77:	1.01	0.52	0.98
HD 102202	8.85	0.22:	0.67	0.39	0.73
HD 105796	8.06	0.95:	1.07	0.55	1.03
HD 106270	7.59	0.30:	0.74	0.40	0.77
HD 119076	6.87	0.89:	1.17	0.61	1.14
HD 119164	7.20	1.15:	1.29	0.65	1.22
HD 128227	8.32	0.81	1.08	0.57	1.10
HD 128618	8.03	1.63	1.47	0.78	1.47
HD 136480	7.35	1.10	1.16	0.61	1.15
HD 137241	7.35	1.07	1.15	0.59	1.10
HD 138363	7.11	0.94	1.14	0.60	1.15
HD 139070	8.68	0.80	1.12	0.60	1.16
HD 154775	7.60	2.02:	1.59	0.86	1.75
HD 156427	7.41	1.71:	1.49	0.80	1.55

HD 106225 = HU Vir is a non-eclipsing RS CVn-type system showing very strong Ca II H&K emission lines and a variable Hα line changing from absorption to emission over the star's rotation cycle (Fekel et al. 1986b; Strassmeier 1994). It has been detected in a radio survey of RS CVn systems (Morris & Mutel 1988; Drake et al. 1989) and its optical variability was first reported by Fekel et al. (1986b). HU Vir has been also suspected to be the possible optical counterpart of the energetic γ-ray burst GRB 930131 (Rao & Vahia 1994). For a detailed study of the physical parameters of HD 106225 see Strassmeier (1994). The observations presented here, obtained over the interval 27 Feb. - 11 Mar., are shown in Fig. 9. The phases have been computed by using the photometric period 10.500 ± 0.093 day, obtained through a Fourier analysis of the *VRI* data. The light curve is a rather peculiar double-peaked curve, showing a very sharp primary maximum and a much smaller secondary peak. The maximum luminosity is the brightest observed to date and also the color indices, whose remarkable variations appear in phase with the V-band modulation, are bluer than those obtained about one year before (Cutispoto 1993). Moreover, in early 1990 the spot distribution on HD 106225 changed remarkably, as the photometry reported by Hall & Henry (1992), (their first observation was obtained about 26 days after the last one of the present data set) shows a rather different light curve with a noticeable secondary maximum and a much fainter luminosity maximum ($V = 8.62$). The best agreement with the observed colors is obtained by assuming a system constituted by a K2 III and a F2 V component. However, no indication of the presence of a hot secondary component was found in IUE spectra (Fekel et al. 1986b). Strassmeier (1994) inferred a K0 IV classification for the primary component and excluded the presence of a luminosity class IV secondary component. We note that a K1 IV classification for the primary component represents the best fit that can be obtained for the observed colors by assuming a single star. An even better fit would be obtained if further observations showed the unspotted magnitude of HD 106225 to be brigher than the value reported in this paper, a circumstance that should correspond to slightly bluer colors. A collection of the available photometry of HU Vir is shown in Fig. 10. Though strong variations of the mean luminosity and of the peak-to-peak amplitude of the light curves are evident, there is not yet evidence for the presence of a solar-type cycle.

HD 119285 = V851 Cen is a SB1 system with an orbital period of 11.9886 days (Saar et al. 1990) that has been studied by several authors in recent years (see Saar et al. 1990; Cutispoto 1993 and references therein) and has been detected by the WFC on board the ROSAT satellite (Pye et al. 1995). Low Li abundance has been reported by Randich et al. (1993). The optical variability was first discovered by Udalski & Geyer (1984) and by Lloyd Evans & Koen (1987). The photometry presented in Fig. 11 was collected over the interval 27 Feb. - 11 Mar. The photometric period of 11.50 ± 0.22 days, obtained from a Fourier analysis of the *VRI* data, was used for the phase computation. The peak-to-peak amplitude of the light curve, only 0.025 magnitudes in the V-band, is the smallest reported to date, while the maximum luminosity is the brightest ever reported. Hence, from the analysis of the available photometry of HD 119285 (Fig. 12) we infer that during the present observations the star was probably very close to its unspotted magnitude. The spectral classification of HD 119285 has been given as K2 III/IV by Bidelman & MacConnel (1973), as K2 IVe by Saar et al. (1990) and as K1 Vp by Houk & Cowley (1975). From the $v \sin i$ computed by Saar et al. (1990) and the published values of the photometric period it is possible to estimate the radius of the main component to be in the range $1.48\ R_\odot \leq R \sin i \leq 1.55\ R_\odot$. This result is consistent with the primary component being a luminosity class IV or V/IV star, and rules out the luminosity classes V and III/IV. In fact, from the data in Fig. 12 it is evident that peak-to-peak amplitudes of the light curve as large as 0.12 magnitudes have been observed: a circumstance that is not consistent with a very small value for the inclination angle "i". Moreover, since the colors of HD 119285 are very similar to those of HD 127535, for which there is evidence of a value of "i" rather close to 90 degree and a radius consistent with a class IV star, we assume a K2 IV classification for the primary component and infer a value of "i" of the order of 25 degrees. Comparing the observed colors with the computed ones, it results that a K2 IV star is the single star that gives the best fit, while a better fit for all the colors except the $U - B$ is obtained by assuming a K3 IV + K2 IV/V classification.

HD 127535 = V841 Cen is a single-lined spectroscopic binary with a 5.998-day orbital period (Collier 1982a) and strong Ca II H&K and Hα emission (Houk & Cowley 1975; Weiler & Stencel 1979; Collier et al. 1982). It was detected at radio (Innis et al. 1985; Slee & Stewart 1989) and EUV (Pounds et al. 1993; Dempsey et al. 1993; Malina et al. 1994; Pye et al. 1995) wavelengths. Randich et al. (1993) report a low Li abundance. The presence of optical variability was discovered by Collier (1982b) and Udalski & Geyer (1984). The spectral classification for the primary component of HD 127535 is given as K1 IV/Ve by Houk & Cowley (1975) and as K1 IV by Collier et al. (1982). The observations obtained over the interval 27 Feb. - 6 Mar. are shown in Fig. 13, where phases have been computed by using the 5.929-day photometric period evaluated by Cutispoto (1990). The peak-to-peak amplitude is the lowest reported to date and the color curves are almost flat. The collection of the available photometry of HD 127535, shown in Fig. 14, confirms the occurrence of a maximum spot coverage during the 1985-87 interval, while the most recent observations (Strassmeier et al. 1994) indicate a much lower degree of spottedness. From the $v \sin i$ value computed by Randich et al. (1993) and the published values of the photometric and orbital periods, the radius of the primary component falls in the range $3.76\ R_\odot \leq R \sin i \leq 3.91\ R_\odot$, consistently with the primary component of HD 127535 being a luminosity class IV or III/IV star. However, from the data in Fig. 14 it is evident that peak-to-peak amplitudes of the light curve as large as 0.24 magnitudes have been observed, so that the value of the angle "i" have to be rather close to 90 degrees, and the radius of the main component is consistent with a class IV star, in agreement with the luminosity class classification inferred by Collier et al. (1982). As for HD 119285, a K2 IV main component gives the best fit of the observed colors obtainable with a single star.

HD 136905 = GX Lib is a SB1 binary with an orbital period of 11.13448 days (Kaye et al. 1995), moderate Ca II H&K emission (Bidelman & MacConnell 1973; Strassmeier et al. 1994), strong Hα absorption (Fekel et al. 1985; Eker et al. 1995) and very low Li abundance (Randich et al. 1993). It was detected by the Einstein (Fleming et al. 1989; Gioia et al. 1990) and by the ROSAT (Dempsey et al. 1993) satellites. Its photometric variability is mainly due to the ellipticity effect, where minor distortions due to starspots are superimposed (Burke et al. 1982; Cutispoto 1993; Kaye et al. 1995 and references therein). The observations obtained over the interval 27 Feb. - 11 Mar. are shown in Fig. 15, where phases have been computed by using the orbital period of 11.13448 days inferred by Kaye et al. (1995). Comparing these data with previous observations the evolution of the light curve appears evident, thus confirming the presence of slowly evolving spotted regions. The weak color variations are in phase with the *V*-band modulation. From the v sin i value inferred by Randich et al. (1993) the minimum stellar radius for the brightest component results in R sin $i \simeq 7.7\ R_{\odot}$. The spectral classification of HD 136905 is given as K1 III + [G-K V] by Strassmeier et al. (1993b) and as K1 III + F by Bidelman & MacConnell (1973). The two best fits of the observed colors are obtained by assuming a K2 III + F5 IV or a K1 III + G5 IV classification, respectively. It should be noted, however, that Fekel et al. (1985) did not find evidence for a F-type component in their UV spectra of HD 136905.

HD 139084 = V343 Nor is a very active RS CVn system showing Ca II H&K emission (Bidelman & MacConnell 1973) and a filled Hα line (Bopp & Hearnshaw 1983). Anders et al. (1991) provided evidence for Pleiades group membership and for a very high Li abundance, the latter result being confirmed by Randich et al. (1993). HD 139084 was detected in a microwave survey of active stars (Slee et al. 1987) and, more recently, at EUV wavelengths by the ROSAT (Pounds et al. 1993; Pye et al. 1995) and EUVE (Malina et al. 1994) satellites. The presence of optical variability was discovered by Udalski & Geyer (1985b). The observations presented here were obtained over the interval 27 Feb. - 11 Mar. and are shown in Fig. 16. Phases have been computed by using the photometric period of 4.25 ± 0.08 days obtained from a Fourier analysis of the *VRI* data. The light curve is double peaked and color variations in phase with the *V*-band modulation are evident. The variation of the photometric period with respect to the 4.567 ± 0.020 days value obtained one year before (Cutispoto 1993) can be noticed. This difference can be qualitatively explained by assuming a different mean latitude of the spots groups and the presence of differential rotation. Moreover, during early 1990 the spot size and/or distribution were subject to noticeable changes. In fact, comparing the data in Fig.16 with those shown in Fig. 4 by Anders et al. (1991), it is evident that from March to July 1990 the light curve changed considerably, reaching the faintest luminosity level ever observed. As it can be seen from the collection of all the available photometry of HD 139084 (Fig. 17), the mean brightness of the star changed dramatically and, after a maximum luminosity observed in early 1987 (Cutispoto 1990), it decreased monotonically in recent years. The spectral classification of HD 139084 is given as K0 V by Houk & Cowley (1975) and as K1 III + F by Bidelmann & MacConnell (1973). No radial-velocity variation is reported by Balona (1987). From the published values of the v sin i and of the photometric period the minimum stellar radius results in the range 1.33−1.53 $R_{\odot}$. This result rules out the K0 V classification and indicates that HD 139084 is not on the main sequence. A good fit of the observed colors except the $U - B$ is obtained by assuming a K0 IV/V classification that, due to the very high Li abundance, could imply that HD 139084 has not arrived on the main sequence yet.

HD 155555 = V824 Ara is a rapidly rotating double-lined spectroscopic binary that has been classified as a pre-main sequence object by Pasquini et al. (1991) and by Martin & Brandner (1995). It was detected at EUV wavelengths by the ROSAT (Pounds et al. 1993; Pye et al. 1995) and by the EUVE (Malina et al. 1994) satellites and has been observed photometrically from late 1979 by several authors (see Cutispoto 1990; 1993 and references therein). The observations presented in Fig. 18 were obtained over the interval 2-9 Mar. Any light contribution from LDS587 B, that lies 33 arcsec apart, was avoided. The light curve is single-peaked with an almost flat maximum and very weak color variations. Phases have been reckoned from the 1.681652-day orbital period computed by Pasquini et al. (1991). The colors are consistent with the G5 IV + K0 IV spectral classification also reported by Pasquini et al. (1991).

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