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Sums of investigation of the linear polarization behaviour of binary systems with a Wolf–Rayet component

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Abstract. Analysis of the long-term (on a scale of years) behaviour of linear polarization of four WR binary systems (CQ Cep, CX Cep, V444 Cyg and HD 211853) is presented. Common features of the long-term polarization variations of CQ Cep, CX Cep and HD 211853 in combination with the results of the harmonic analysis of their polarization curves allowed us to make assumptions on the causes of the found variability. The basic reason of the long-term polarization variability is likely to be the physical activity of the WR components which manifests itself in the episodic swelling of the WR envelopes and subsequent expulsion of their outermost layers. The involvement into the study of five wider "WR+O" pairs (HDE 311884, HD 90657, HD 97152, HD 152270 and HD 186943) allowed us to confirm these assumptions. The results of the analysis of the polarization curves of nine WR binary systems are summed up. Three confirmations of high massiveness of the WR component HDE 311884 have been derived.

Key words: stars: binaries — stars: Wolf-Rayet — stars: fundamental parameters: polarization

1. Introduction

By the beginning of fulfilment of our program of polarimetric studies (1994) a great series of observations of polarization variability of WR binary systems and WR stars suspected to be binaries had been accumulated by the group of A. Moffat. The main results of these studies are given in the paper by Schulte-Ladbeck and Van der Hucht (1989). They reported that all double-lined WR binaries which have been observed polarimetrically (12 out of 23) show double-wave phase-dependent variations of linear polarization (P) predicted in the model of Thomson scattering of the radiation of the O companion by free electrons of the WR envelope (Brown et al. 1978). The polarization behaviour of three of them (Θ Mus, γ^2 Vel and HD 190918) that contain supergiant O companion are somewhat different: a variability of random character is obviously superimposed on the phase-dependent polarization variability. This random variability is supposed to be caused by the physical processes that occur in the supergiants (see St.-Louis et al. 1987). These three systems possess the longest orbital periods ($18^d.34$, $78^d.5$, $112^d.8$, respectively). The last two systems (γ^2 Vel and HD 190918) have considerable orbit eccentricities, which complicate the shape of their polarization curves and make difficult analysis of the latter.

For the majority of WR binaries observed polarimetrically, the polarization variations are well described by the canonical model of polarization behaviour in a binary system with a circular orbit (Rudy and Kemp 1978; Brown et al. 1978). A harmonic analysis of the polarization curves of these systems with the involvement of the above-mentioned model makes it possible to determine the parameters of their orbits (inclination and orientation) and obtain information about the character of distribution of the scattering matter in the WR envelope. Analysis of polarization curves of long-period WR binaries with the orbit eccentricity is more difficult and is considered separately in the paper by Brown et al. (1982).

The values of the system orbit inclinations determined from polarimetric investigations (i_{pol}) permit accurate masses of the components of spectral-binary WR systems to be derived irrespective of whether they are eclipsing or not. Besides, measurements of the amplitudes of the phase-dependent polarization variations of WR binary systems make it possible to obtain reliable estimates of the electron density of WR envelopes and of the rate of mass loss by WR stars (St.-Louis et al. 1988).

Schulte-Ladbeck and Van der Hucht (1989) noted, however, that the observational material summarized in their paper admits analysis of polarization variation on a time scale from a few days to a month. There are no data on short-period polarization variations of WR stars. Very little is known about long-term variability of their polarization on scales greater than several months.

2. Analysis of long-term polarization behaviour of close WR binary systems (CQ Cep, CX Cep, V444 Cyg and HD 211853)

The study of the long-term (on a scale of years) polarization behaviour of WR binary system or, in other words, the check of stability of the polarization curves (P–phase) of these systems with time, was the aim of our observations carried out with the telescope "Zeiss–1000" of SAO RAS in 1994–1999. During this period we obtained four series of observations for CQ Cep (two series in 1994 and 1996 with the polarimeter of I.D. Naidenov and two series with the polarimeter "MINIPOL" in 1998 and 1999) (Kartasheva et al. 1998, 2000), one series of observations for CX Cep (in 1998 with the polarimeter "MINIPOL") (Kartasheva 2002c), and fragmentary observations registered, however, the phases of extreme polarization values for HD 211853 and V444 Cyg (with the polarimeter "MINIPOL" in 1999) (Kartasheva 2002b). A comparison of our data with those obtained earlier gave the following results.

1. For the three systems (CQ Cep (P = $1\overset{d}{.}64$), CX Cep (P = $2\overset{d}{.}13$) and HD 211853 (P = $6\overset{d}{.}69$)) a considerable long-term polarization variability ($\Delta P \approx 1\%$) was found.

2. The character of this variability for the WR systems with a common envelope (CQ Cep and CX Cep) and for a wider "WR+O" pair, a member of the quadrupolar system HD 211853, having common features, turned out to be somewhat different.

3. A remarkable constancy with time of the polarization curve of V444 Cyg (P = $4\overset{d}{.}21$) was confirmed.

A comparison of the character of the long-term variability of polarization of the three above-mentioned systems showed the presence of certain common features. For the closest WR binary systems (CQ Cep and CX Cep) (see Figs. 1 and 2, observations of 1994 for CQ Cep and observations of 1998 for CX Cep) sharp rises of the entire polarization curve ($\Delta P \approx 1\%$) accompanied by the sharp increase of the amplitude of the phase-dependent polarization variations are the common feature. The results of the harmonic analysis of these anomalous curves showed a sharp increase (2–3 times) of the electron density (n_e) of the WR envelopes and a mass loss rate by the WR stars ($\dot{m}_{WR}$), and also a rise of the degree of asymmetry of the matter distribution with respect to the orbital plane of the system and an increase in the degree of matter concentration towards the same plane (Kartasheva et al. 1998; Kartasheva 2002c). The common feature was also noted in the character of the long-term polarization variability of CQ Cep and HD 211853, sharp decrease of P ($\Delta P \approx 1\%$) at phases of the conjunction, when the O star is located at the front (see Figs. 1 and 3, observations of 1996 for CQ Cep and observations of 1999 for HD 211853). The harmonic analysis of these polarization curves has shown a sharp drop in n_e and $\dot{m}_{WR}$ and a decrease of the matter concentration towards the system orbit planes (Kartasheva et al. 1998).

The revealing of the common features in the character of the long-term polarization variations of CQ Cep, CX Cep and HD 211853 together with the fact of the remarkable constancy of the V444 Cyg polarization curve (see Fig. 4) (Kartasheva 2002b) allowed us to make a series of assumptions on the causes of these variations. The basic reason of the discovered long-term polarization variations is likely to be the physical activity of the WR components which manifests itself in the episodic swellings of the WR envelopes and subsequent expulsion of their outermost layers. Probably, it is this swelling that leads to the sharp rise of the constant component of polarization of the closest WR binary systems (CQ Cep and CX Cep), which results in the sharp rise of their polarization curves as a whole. However, our results suggest that the activity of the WR components is not always a direct and sufficient cause of the long-term polarization variations. The fact that in two WR systems, showing long-term polarization variations, abrupt drops of P occur at phases of the conjunction, in which the O star is at the front, permitted us to draw one more assumption. Brightness variations (nonpolarized light) of the O companion (and in the case of the system with a common envelope, of both companions) caused by the activity of the WR star are likely to be a direct cause of the sharp variations of the polarization curve amplitudes of the considered systems. Remind the relation of the degree of polarization and intensity of polarized (I_{polar}) and non-polarized ($I_{nonpolar}$) light:

$$P = I_{polar}/(I_{polar} + I_{nonpolar}).$$

If the situation for the systems with the common envelope (CQ Cep and CX Cep) is clear, since the swelling of the WR envelope or the expulsion of its outermost parts lead directly to weakening or brightening of the stars, then in the case of broader "WR+O" pairs everything must be more complicated. Probably, for these systems the fact whether the WR envelope overfills the inner critical lobe (ICL)

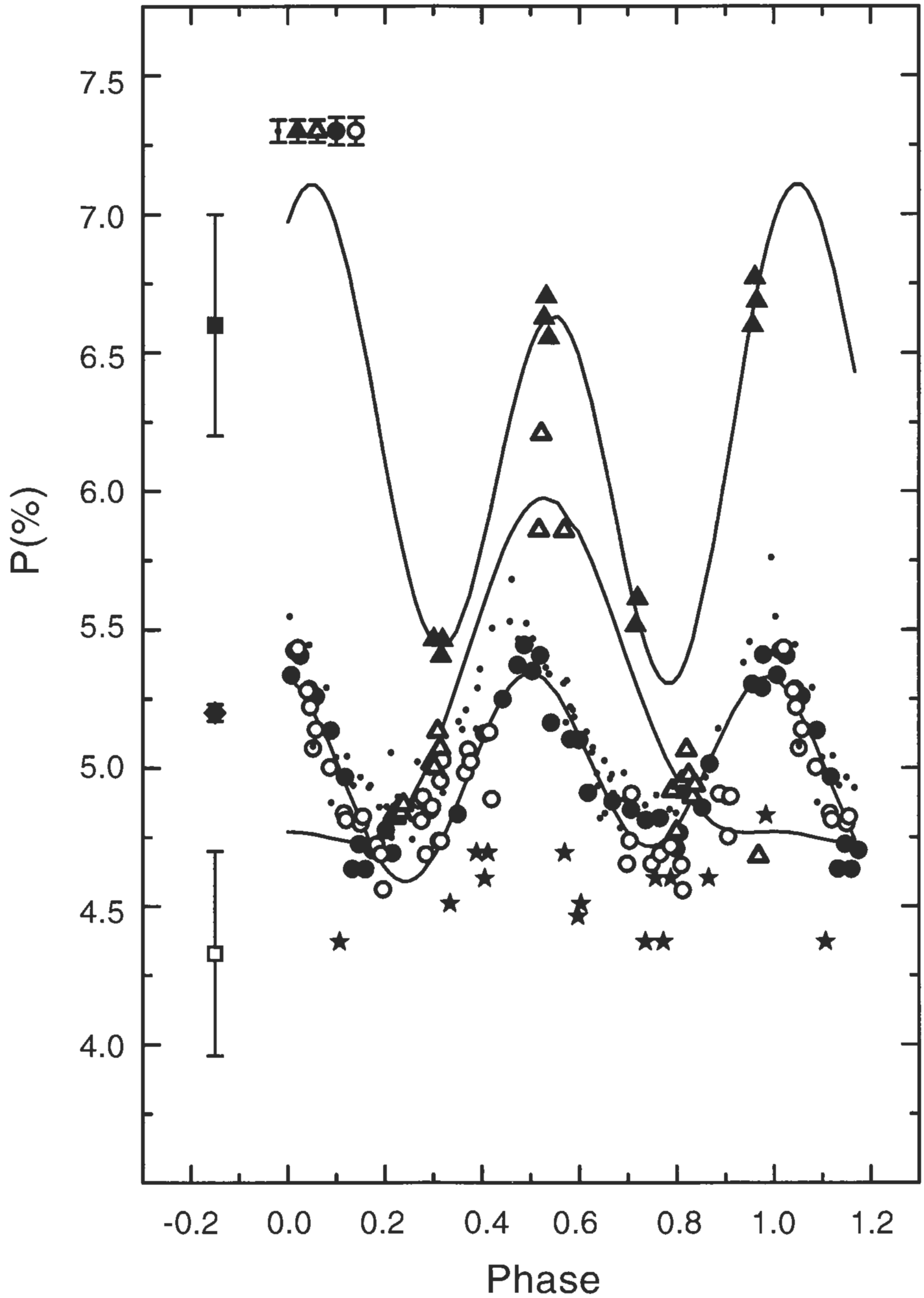

Figure 1: *The curves of linear polarization variations with the orbital period phase derived for CQ Cep from the results of 1948 observations (Hiltner (1950), asteriscs), 1984 observations of Drissen et al. (1986) (dots), our 1994 observations (filled triangles) and 1996 (open triangles) (Kartasheva et al. 1998), 1998 (filled circles) and 1999 (open circles) (Kartasheva et al. 2000). The solid lines are the theoretical representation of our 1994, 1996 and 1998 observations. The mean P values obtained in the 1950 observations of the system by Hiltner (1951), in the fall of 1951 by Dombrovsky and Novochadova (1953) and at the end of 1961 by Shakhovskoy (1964) are plotted along the polarization axis (a filled diamond, filled square and an open square, respectively).*

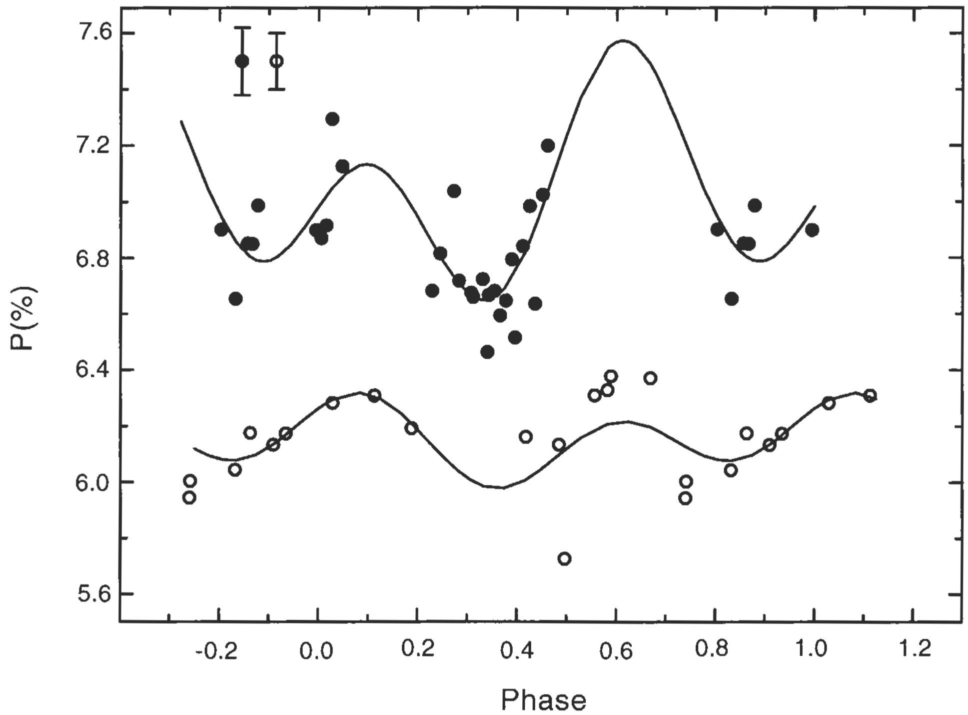

Figure 2: *The curves of linear polarization variations with the orbital period phase plotted for CX Cep from the results of our observations in 1998 August (Kartasheva 2002c) (filled circles). The open circles present the results of 1987 observations by Schulte-Ladbeck and Van der Hucht (1989). The solid lines are the theoretical representation of the curves.*

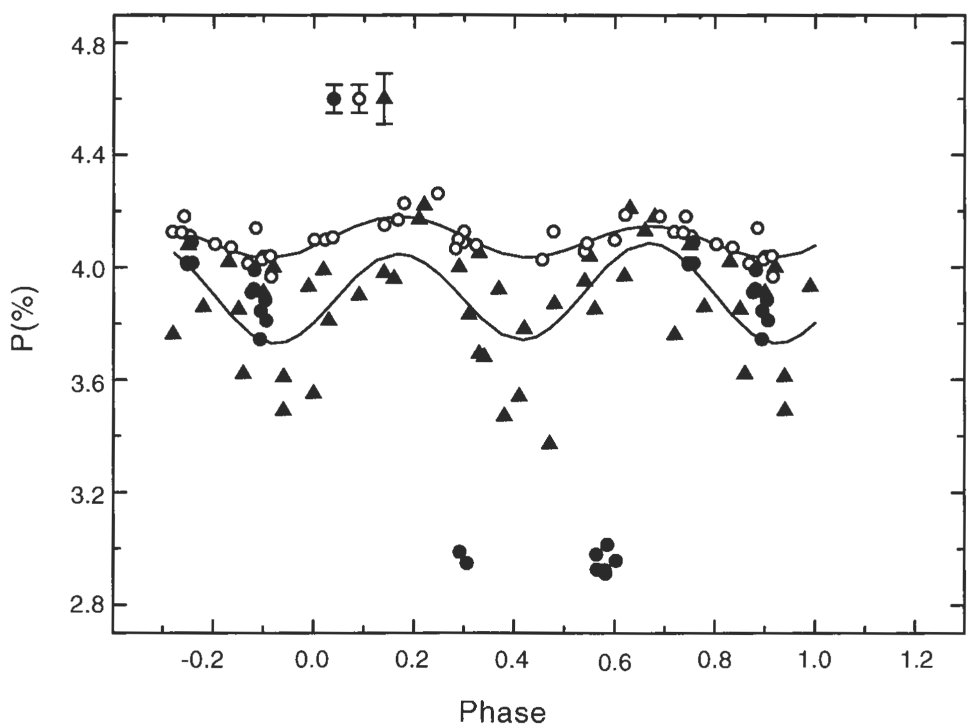

Figure 3: *The curves of linear polarization variations with the orbital period phase plotted for HD 211853 from the results of our 1999 observations (Kartasheva 2002b) (filled circles). The open circles present the results of St.-Louis et al. (1988) (1984–1986 observations). Triangles are the results of Polyakova (1993) (observations of 1989). The solid lines represent the theoretical curves.*

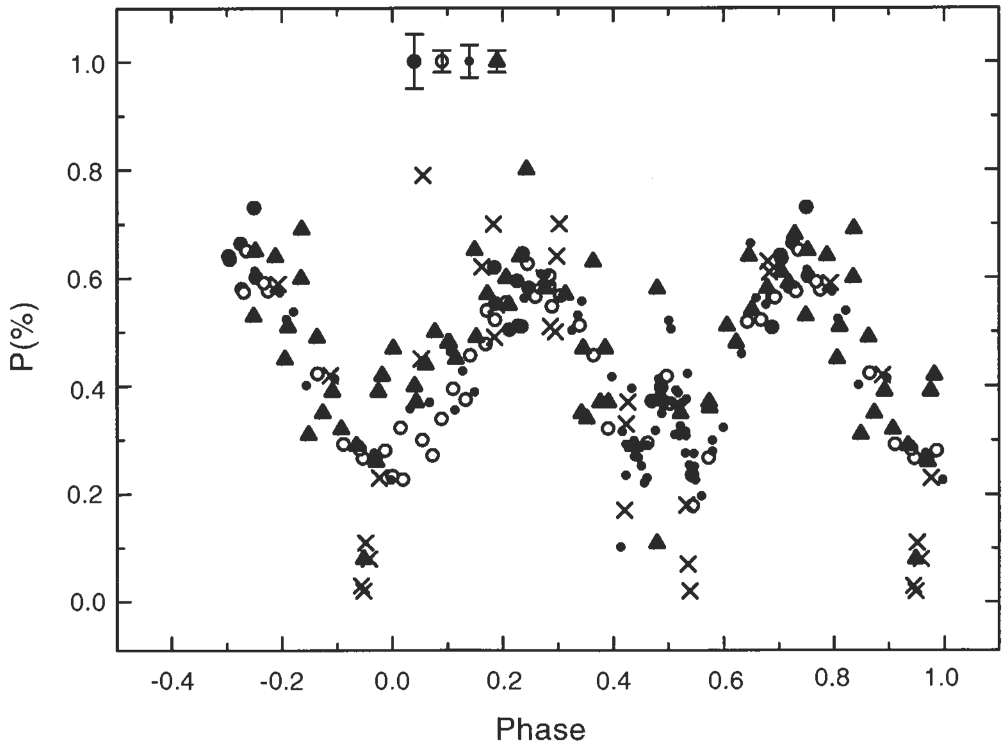

Figure 4: *The curves of linear polarization variations with the orbital period phase constructed for V444 Cyg from the results of the 1965–1966 observations of Hiltner and Mook (1966) (crosses), the 1976 observations of Rudy and Kemp (1978) (filled triangles), the 1985–1986 observations of Robert et al. (1990) (open circles), the 1988–1989 observations of St.-Louis et al. (1993) (dots) and our 1999 September observations (Kartasheva 2002b) (filled circles).*

of the WR star or not will be decisive. Four situations and four corresponding to them variants of long-term behaviour of linear polarization of the systems being discussed are possible here.

1. Neither in a quiet nor in an excited state the WR envelope overfill the ICL of its star. Long-term polarization variations must not be observed because the O-star brightness does not change.

2. In an excited state the WR envelope fills the ICL of the WR star, and its matter flows into the ICL of the O star. An envelope is formed around the latter and the star grows dim. The expulsion of the peripheral parts of the WR envelope, that follows, it is likely to carry off the matter of the recently formed O-envelope. Since after the outflow of the external parts, the WR envelope returns to the ICL of its star, then the O star, free from the envelope, acquires its former brightness. The long-term linear polarization variations in such WR systems must be observed and they are likely mainly to occur in the phases of the conjunction when the O star is at the front. Probably such a situation takes place in the "WR+O" pair being a member of HD 211853.

3. The WR envelope always (in quiet and excited states) overfills the ICL of its star without forming a common envelope for the system. There is always an envelope around the O star, which forms from the matter flowing from the WR envelope into the ICL of the O star. Even if it is destroyed at the time of expulsion of the outermost parts of the WR envelope, it will be immediately restored. No variations in the brightness of the O star in connection with the activity of the WR component will occur. Long-term polarization variations must not be observed in such WR binary systems. Probably, this case is realized in V444 Cyg.

4. The WR envelope always overfills the ICL of the WR star forming a common envelope for the system. Long-term linear polarization variations must be observed in such systems and will have a more complicated character than in case 2. This situation occurs in CQ Cep (and, probably, in CX Cep), where the sharp decrease of polarization, occurring at the phases of conjunction, when the O star is at the front, superimposes on the abrupt drop of the entire polarization curve (see Fig. 1, the 1996 observations). The correctness of our reasonings could be corroborated by the detection of wider "WR+O" pairs in which the long-term polarization variations are absent.

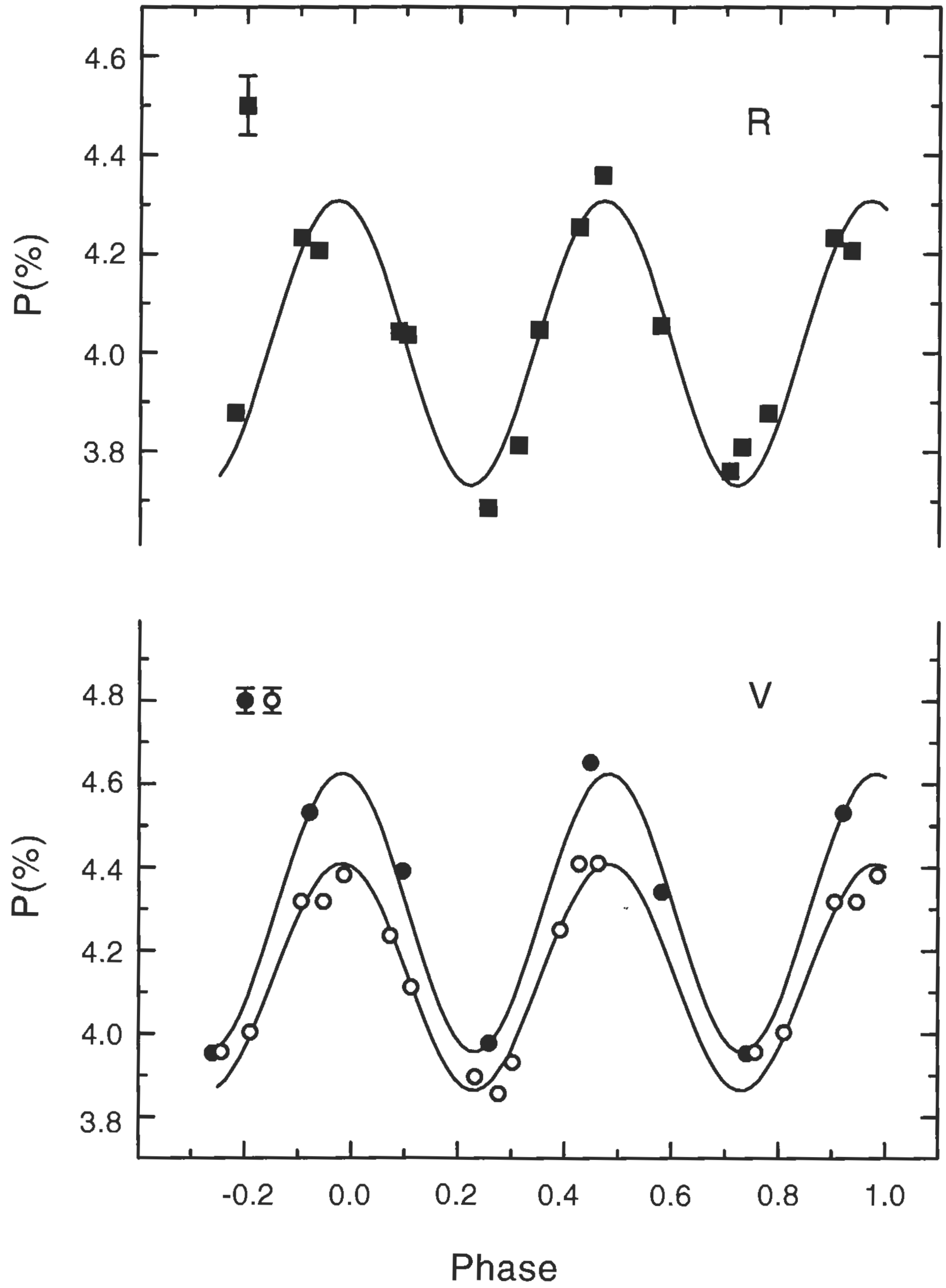

Figure 5: *The curves of linear polarization variations with the orbital period phase derived for HDE 311884 from the results of the 1987 May observations of Moffat and Seggewiss (filled circles), 1988 March observations of San Guan (open circles) and 1987 February observations in SAAO (filled squares) (Moffat et al. 1990).*

3. Analysis of the long-term polarization behaviour of broader WR binary systems

Five broader "WR+O" pairs studied polarimetrically by different authors (HDE 311884 ($P = 6^{d}.34$), HD 97152 ($P = 7^{d}.86$), HD 90657 ($P = 8^{d}.2$), HD 152270 ($P = 8^{d}.89$) and HD 186943 ($P = 9^{d}.56$)) were involved in the further analysis. However, polarization observations of these stars have been found to be very scanty. In particular, HD 90657 and HD 186943 have been observed only once (Moffat and Seggewiss 1987 and St.-Louis et al. 1988, respectively) and nothing can be said about the long-term variability of their polarization. Three systems, HDE 311884, HD 97152 and HD 152270, are left.

HD 311884

The polarization curve of HD 311884 which shows

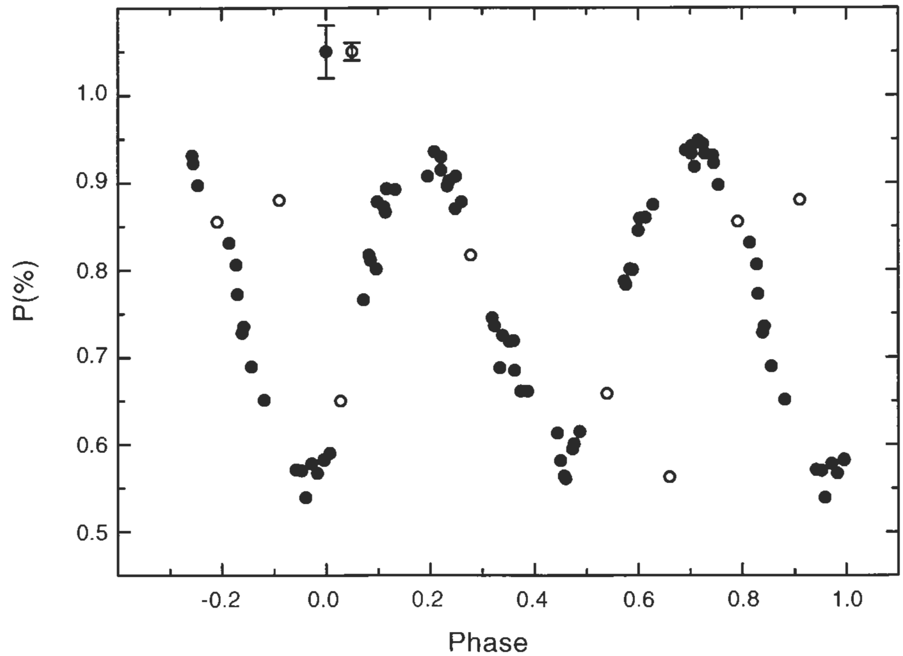

Figure 6: *The curves of linear polarization variations with the orbital period phase drawn for HD 97152 from the results of the 1986 observations of St.-Louis et al. (1987) (filled circles) and the 1991 observations of Moffat and Pirola (1996) (open circles).*

clearly the signs of a common envelope in the system (for the "mirror" behaviour of the polarization curves of three WR binaries, CQ Cep, CX Cep and HDE 311884, see the papers by Kartasheva et al. (1998) and section 4.1 of the given paper) was observed only once in the R band in 1987 and twice in the V band with an interval of about a year (in 1987 and 1988) (Moffat et al. 1990), see Fig. 5. Over this year the amplitude of the phase-dependent polarization variations decreased by 0.1 %, which was accompanied by a 0.15 % drop of the average level of polarization ($\bar{P}$). So the long-term polarization variations of HDE 311884 are similar in character to those of the closest WR binary systems (CQ Cep and CX Cep) whose polarization curves show a direct correlation between their amplitudes (A) and $\bar{P}$ (see Kartasheva et al. 1998, Kartasheva 2002c). It is surprising that rather a wide system has a common envelope. However, HDE 311884 is likely to be a very massive WR binary. Its spectroscopic studies (Niemela et al. 1980) point to the great mass of the WR component ($m_{WR} \approx 50 m_{\odot}$), approximately 3–5 times as large as the mass of WR stars in other "WR+O" pairs. If it is so, then the envelope of the WR star must be also more massive and extended. The long-term polarization behaviour of the HDE 311884 undoubtedly needs further investigation.

HD 97152

The polarization observations of the system were carried out twice: in 1986 (St.-Louis et al. 1987) and in 1991 (Moffat and Pirola 1996), both times in the B band. The first series of observations was very detailed, the second one consisted of six linear polarization estimates covering, however, the entire orbital period of the system (see Fig. 6). It is seen from the figure that three of these estimates at phases > $0^{p}.5$ (conjunction in which the O star is at the front) are inconsistent with the polarization curve derived for the system by St.-Louis et al. (1987). Probably, we observe the long-term polarization variability of the system but considerably lower ($\Delta P \approx 0.3\%$) than in the case of closer WR binary systems, and even its character is different. It can be assumed that this variability is related to the gas stream arising temporarily around the O companion as a consequence that the WR envelope in HD 97152 almost fills the ICL of its star.

HD 152270

The system was observed polarimetrically three times in the B band: in 1980 (Luna, 1982), 1986 (St.-Louis et al. 1987), and 1991 (Moffat and Pirola 1996). In the first two sets dense series of observations were obtained, in the last one seven polarization measurements along the orbital period were made. After the recalculation of the phases of the observations of Luna (1982) with more accurate value of the orbital period (P = $8^{d}.8908$), all the three series of observations were in good agreement (see Fig. 7). In other words, in the time interval of eleven years the system did not show any long-term linear polarization variations.

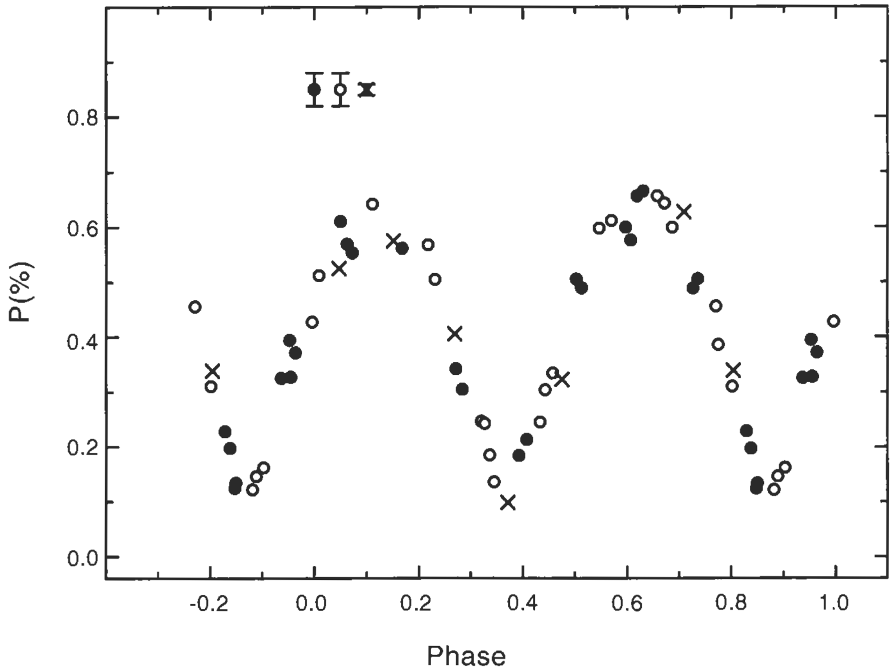

Figure 7: *The curves of linear polarization variations with the orbital period phase plotted for HD 152270 from the results of the 1980 observations of Luna (1982) (filled circles), the 1986 observations of St.-Louis et al. (1987) (open circles) and the 1991 observations of Moffat and Pirola (1996) (crosses).*

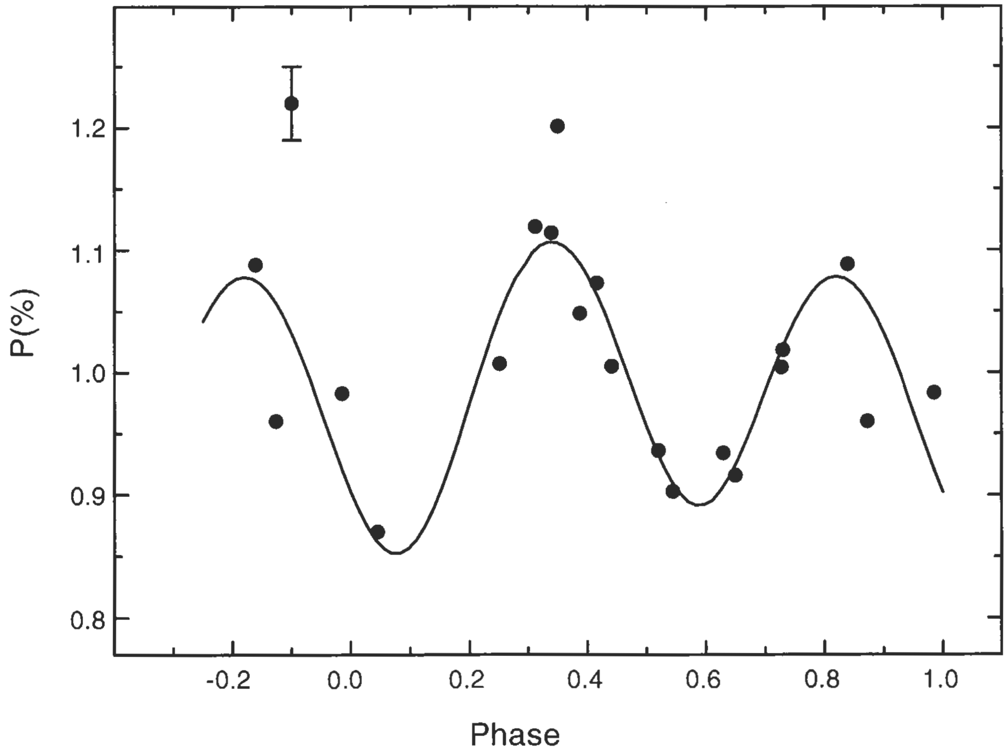

Figure 8: *The curve of the linear polarization variations with the orbital period phase plotted for HD 186943 using the results of the 1984–1985 observations of St.-Louis et al. (1988).*

So, the threshold value of the orbital period of WR binary systems (P $\approx 9^d$) and the corresponding to it distance between the stars' centers ($a_{WR}+a_O \geq 60R_\odot$) at which the WR envelope is within the ICL of its star were roughly estimated. To confirm and refine this result, repeat observations of two WR binaries, HD 90657 and HD 186943, are needed. The polarization curve of the latter is shown in Fig. 8 and the curve of HD 90657 see in Fig. 1 of the paper by Moffat and Seggewiss (1987).

Of three widest "WR+O" pairs with supergiant O companions, Θ Mus (P = $18^d_.8$), γ^2 Vel (P = $78^d_.5$) and HD 190918 (P = $112^d_.8$), only γ^2 Vel was repeatedly observed polarimetrically (Luna 1985; St.-Louis et al. 1987; Serkowski 1970; Haefner et al. 1977). The polarization curve of this system (see Fig. 7 of the paper by St.-Louis et al. 1987), although being noised by random variations caused by physical processes occurring in the supergiant O companion, does not show any long-term variations. The latter corroborates our conclusions drawn above.

4. Sums of investigation of the linear polarization of WR binary systems of different degree of closeness

4.1. On the shape of the polarization curves of WR binary systems

While examining the polarization curves of the nine WR binary systems (four studied by us and five attracted additionally) it is seen that they can be divided into two groups. The greater part of them shows the polarization curves of classical shape: maximal values of polarization (P_{max}) fall approximately on the elongations, i.e. on the maximum light of the system, and minimal values of polarization (P_{min}) are at conjunctions, when the system brightness is minimum. However, three systems (CQ Cep, CX Cep and HD 311884) have "mirror" polarization curves with respect to the light curves ($P_{max} \approx$ in conjunctions, and $P_{min} \approx$ in elongations). The problem on the "mirror" behaviour of the polarization curves of these systems was not discussed in the papers devoted to polarimetric studies of CX Cep and HD 311884 (Schulte-Ladbeck and Van der Hucht 1989, Moffat et al. 1990, respectively). Drisen et al. (1986), when analysing the polarization curve of CQ Cep, made an attempt to remove the "anomaly" of its shape by taking into account the eclipsing effects (i.e. by taking into account the rise of the degree of polarization in the light minima because of the sharp drop of unpolarized light of stars). However, they managed to decrease the "anomaly" but not to remove it. Keeping in mind that HDE 311884 is an uneclipsing binary, it becomes obvious that in close binary systems with a common envelope, apart from the eclipsing effects there are other reasons for rising polarization at phases of the minima of light.

In this connection a known fact should be reminded that nearly all the light curves derived for CQ Cep in the emission lines are also "mirror" with respect to the continuum light curves (Hiltner 1950; Bappu and Sinvhal 1955, 1959; Khaliullin and Cherepashchuk 1970; Khaliullin 1972; Shylaja 1986), while the intensity emission line curves for V444 Cyg show a decrease of I_{emis} at the minima of continuum light (Kuhi 1968).

Comparing for CQ Cep the behaviour of linear polarization and intensity of emission lines, it can be assumed that in both cases the observed effects are related to the character of the matter distribution (both scattering and emitting in lines) inside the system. CQ Cep is a close, practically contact pair. Besides, a dense plasmoid exists obviously between its components. It manifests itself both as an object absorbing light at the phases after the second minimum of light and as an object providing additional radiation in the continuum, which introduces significant distortions in the light curve of the system (Kartasheva and Svechnikov 1996). On the other hand, the O star is embedded in the WR envelope, and the matter of the latter must be thickened on sides of the O star.. At phases $0^P_.0$ and $0^P_.5$ the optical depth of this flowing matter will be rather great, and near the hot O star all conditions will be created for effective scattering of its radiation. An additional contribution to the polarization at these phases may also be made by the scatter on the free electrons of the WR envelope of the emission of the plasmoid between the stars. A similar situation is likely to take place also in CX Cep, a WR binary system a little less close than CQ Cep.

As to HDE 311884, we have already noted, with reference to the spectroscopic studies of Niemela et al. (1980), that in such a massive system with $m_{WR} \approx 50m_\odot$ the WR envelope must be both more massive and more extended. Probably, it is this fact that ranks HDE 311884 with the two closest "WR+O" pairs.

In this connection, it is interesting to analyse the estimates of the moments of the electron distribution $\tau_0\gamma_3$ and $\tau_0\gamma_4$ (Brown et al. 1978) derived from the harmonic analysis of the polarization curves of the considered systems. These parameters describe the concentration of electrons within the orbital plane. Table 1 lists the values of $\lambda_2 = 1/2arctan(\gamma_4/\gamma_3)$, the angle between the direction to the main mass of scattering matter and the line of conjunction of the stars. As it is seen from the table, the values of λ_2 for the majority of systems are small and suggest that within the orbital plane the scattering matter is concentrated along the line of conjunction of stars. In the case of HD 152270 to explain the matter concentration at an angle $\lambda_2 \approx 45°$ to the line of conjunction of stars St.-Louis et al. (1987) had to involve the jet

Table 1: *The values of the parameter λ_2 following from the analysis of the polarization curves of nine WR binary systems*

Name of the star	$\overset{\circ}{\lambda_2}$	Source
CQ Cep	17.5	Drissen et al. 1986
($P = 1^{d}.64$)	-12.3	Kartasheva et al. 1998 (observ.1994)
	-8.1	Kartasheva et al. 1998 (observ. 1996)
	5.1	Kartasheva et al. 2000 (odserv. 1998)
CX Cep	41.2	Kartasheva 2002a
($P = 2^{d}.13$)	-29.1	Kartasheva 2002c
V444 Cyg	-3.4	Robert et al. 1990
($P = 4^{d}.21$)	-0.8 ± 1.6	St.-Louis et al. 1993
HDE 311884	10 ± 6	Moffat et al. 1990 (SAAO)
($P = 6^{d}.34$)	5 ± 2	Moffat et al. 1990 (ESO)
	-4 ± 2	Moffat et al. 1990 (San Juan)
HD 211853	-7	St.-Louis et al. 1988
($P = 6^{d}.69$)	-28.7	Polyakova 1993
HD 97152 ($P = 7^{d}.86$)	-26.5 ± 5.7	St.-Louis et al. 1987
HD 90657 ($P = 8^{d}.26$)	——	Moffat and Seggewiss 1987
HD 152270 ($P = 8^{d}.89$)	-44.8 ± 3.6	St.-Louis et al. 1987
HD 186943 ($P = 9^{d}.55$)	-13.3	St.-Louis et al. 1988

effects in the wind. The fact that the angle λ_2 for CQ Cep is also small gives evidence that the scattering matter is concentrated along the line almost parallel to the line of conjunction of stars. It is exactly in this manner that the matter thickened by the intrusion of the O star in WR envelope is settled. As regards CX Cep, the values of λ_2 following from the harmonic analysis of its two polarization curves are large enough and are, possibly, caused by jet effects in the wind as in the case of HD 152270.

4.2. The results of the harmonic analysis of the polarization curves of the studied systems

As it was stated in the introduction of the paper, the harmonic analysis of the polarization curves of WR binaries and the use of the model of Brown et al. (1978) allows the parameters of their orbits, inclination (i_{polar}) and orientation in space (Ω), to be determined. The angles Ω_1 and Ω_2 in this model, which are the turn angles of the major axes of (q_-u_-) and (q_+u_+) ellipses with respect to the q axis of the equatorial coordinate system, are connected between themselves by the relation $|\Omega_1 - \Omega_2| \approx 90^\circ$ (the condition of orthogonality of the ellipse axes described by the first and second expansion harmonics). Table 2 collects the estimates of $\Omega_1, \Omega_2, \Delta\Omega$ and i_{pol} obtained from the analysis of the polarization curves involved in the study of WR binary systems. In column 6 of Table 2 we present for comparison the estimates of the orbit inclination of the systems made from photometric investigations (i_{phot}). It can be seen from the table that for wider "WR+O" pairs, in which the long-term polarization variations are absent or small, the con-

Table 2: *The parameters of the orbit derived for the considered "WR+O" pairs from the analysis of their polarization curves*

Name of the star	Ω_1°	Ω_2°	$\Delta\Omega^\circ = \lvert\Omega_1 - \Omega_2\rvert$	i_{pol}°	i_{phot}°	Source
CQ Cep	101	343	118	77.9 ± 2.0		(1)
	29	140	111	70.1 ± 3.0		(2)(1994)
	310	180	130	88.8 ± 3.0		(2)(1996)
	327	247	80	84.1 ± 3.0	68.0 ± 2.0	(3)
CX Cep	316	58	102	53.9 ± 5.0		(4)+(5)
	311	140	171	81.1 ± 5.0		(6)
					53.3 ± 3.0	(7)
V444 Cyg	335	316	19	78.7 ± 0.5		(8)*
					78.0 ± 1.0	(9)
HDE 311884	169	314	145	81.5 ± 2.0		(10)(ESO)*
	340	107	127	72.5 ± 2.0		(10)(San Juan)*
					67.0 ± 2.0	(11)
HD 211853	120	171	159	78.2 ± 1.0		(12)+(14)
	158	202	44	56.8 ± 2.0		(13)+(14)
					74.0 ± 0.7	(11)
HD 97152	326	223	103	43.5 ± 3.0		(15)*
					40.3 ± 2.9	(11)
HD 90657	—	—	—	56.6 ± 6.0		(16)
					49.6 ± 3.7	(11)
HD 152270	319	214	105	44.8 ± 3.0		(15)*
					33.6 ± 2.3	(11)
HD 186943	93	7	86	55.7 ± 8.2		(12)*
					55.3 ± 4.7	(11)

* — the results of our repeat harmonic analysis taking into account not only the second but also the first harmonics.
References for the Table 2:
(1) Drissen et al. 1986, (2) Kartasheva et al. 1998, (3) Kartasheva et al. 2000, (4) Schulte-Ladbeck and Van der Hucht 1989, (5) Kartasheva 2002a, (6) Kartasheva 2002c, (7) Lipunova and Cherepashchuk 1982, (8) Robert et al. 1990, (9) Cherepashchuk 1975, (10) Moffat et al. 1990, (11) Lamontagne et al. 1996, (12) St.-Louis et al. 1988, (13) Polyakova 1993, (14) Kartasheva 2002b, (15) St.-Louis et al. 1987, (16) Moffat and Seggewiss 1987.

dition of orthogonality of the ellipse axes described by the first and second harmonics is fulfilled within the errors of determination of Ω ($\Delta\Omega = 8 - 15^\circ$). Here the agreement between i_{pol} and i_{phot} is also good, but for HD 152270. For closer pairs the condition $|\Omega_1 - \Omega_2| \approx 90^\circ$ is violated. However, in spite of this, for V444 Cyg an excellent agreement is reached between the values i_{pol} and i_{phot}, which is not the case with WR binaries showing instability of the polarization curves with time. One should, probably, take care in determining the orbit inclinations of the latter, showing preference to those estimates of i_{pol} which follow from the analysis of the polarization curves that reflect the most quiescent state of the systems (the curves with the lowest level of $\bar{P}$). For such polarization curves the analysis yields also an acceptable value $|\Omega_1 - \Omega_2| \approx 90^\circ \pm 20^\circ$. It is such a situation that we came across in the analysis of the polarization curve of CX Cep derived in 1987 by Schulte-Ladbeck and Van der Hucht (1989). Correct estimates of i_{pol} for CQ Cep, HDE 311884 and HD 211853 are not obtained yet apparently because there are no reliable

Table 3: *The parameters characterizing the electron density and the distribution of the scattering matter in the WR envelopes derived from the analysis of the polarization curves of the considered systems*

Name of the star	$\tau_0 G$ ($\times 10^{-3}$)	$\tau_0 H$ ($\times 10^{-3}$)	H/G	A_p ($\times 10^{-3}$)	Source
CQ Cep	0.36	3.58	10.2	3.74	(1)
	3.06	6.95	2.2	7.75	(2)(1994)
	3.16	3.28	1.0	3.28	(2)(1996)
	0.52	3.72	7.2	3.76	(3)
CX Cep	0.51	0.90	1.8	1.20	(4)+(5)
	1.51	4.33	2.9	4.43	(6)
V444 Cyg	0.12	1.74	14.5	1.78	(7)*
HDE 311884	0.48	3.41	7.1	3.49	(8)(ESO)*
	0.48	2.76	5.8	3.01	(8)(San Juan)*
HD 211853	0.16	1.52	9.5	1.58	(9)+(11)
	0.26	1.47	5.7	1.92	(10)+(11)
HD 97152	0.11	1.24	11.3	1.90	(12)*
HD 152270	0.10	1.80	18.0	2.70	(12)*
HD 186943	0.19	0.87	4.6	1.15	(9)*

* — the results of our repeat harmonic analysis.
References for the Table 3:
(1) Drissen et al. 1986, (2) Kartasheva et al. 1998, (3) Kartasheva et al. 2000, (4) Schulte-Ladbeck and Van der Hucht 1989, (5) Kartasheva 2002a, (6) Kartasheva 2002c, (7) Robert et al. 1990, (8) Moffat et al. 1990, (9) St.-Louis et al. 1988, (10) Polyakova 1993, (11) Kartasheva 2002b (12) St.-Louis et al. 1987.

polarization curves showing quiet state of the system with minimum $\bar{P}$. For CQ Cep one should expect $\bar{P}_{min} \approx 4.5\%$ (Hiltner 1950 and Shakhovskoy 1964), for HD 211853 $\bar{P}_{min} \approx 3.4\%$ (Kartasheva 2002b).

The use in the analysis of the polarization curves of WR binary systems of the model of Brown et al. (1978) makes it possible to obtain also information about the character of distribution of the scattering matter in the WR envelope. The data on the parameter λ_2 which characterizes the location of the main mass of the scattering matter relative to the line of conjunction of the components have already been discussed in Section 4.1 (Table 1). For all the considered systems Table 3 presents the estimates of the parameters $\tau_0 G, \tau_0 H, H/G, A_p$. They all are the functions of four spatial integrals ($\tau_0\gamma_1, \tau_0\gamma_2, \tau_0\gamma_3, \tau_0\gamma_4$) following from the analysis of the polarization curves and characterizing the distribution of the scattering matter in the WR envelope.

$$\tau_0 G = \tau_0({\gamma_1}^2 + {\gamma_2}^2)^{1/2}, \tau_0 H = \tau_0({\gamma_3}^2 + {\gamma_4}^2)^{1/2},$$
$$A_p = \tau_0({\gamma_3}^2 + {\gamma_4}^2)^{1/2}(1 + cos^2 i).$$

The parameter G characterizes the degree of asymmetry of the scattering matter distribution with respect to the orbital plane of the system. The parameter H characterizes the degree of concentration of the scattering matter towards the same plane (τ_0 is the effective optical depth of the Thomson scattering integrated over the envelope). A_p is the value of the major semi-axis of the ellipse described by the second harmonics, which characterizes the envelope electron density (n_e) and the mass loss rate by the WR star. $A_p \sim n_e \sim \dot{m}_{WR}$ according to equations (3)–(5) of the paper by St.-Louis et al. (1988). It is difficult to compare the estimates of the parameters $\tau_0 G$ and $\tau_0 H$ for different systems since the factor τ_0 is unknown. However, it is seen from Table 3 that the systems are divided into two groups. For all the systems, except the systems with a common envelope, the values $\tau_0 G$, $\tau_0 H$ and A_p are within the narrow limits:

$$0.11 \times 10^{-3} \leq \tau_0 G \leq 0.26 \times 10^{-3};$$
$$0.9 \times 10^{-3} \leq \tau_0 H \leq 1.8 \times 10^{-3};$$
$$1.15 \times 10^{-3} \leq A_p \leq 2.70 \times 10^{-3}.$$

Table 4: *The parameters of interstellar polarization in the direction of the discussed systems, q_I, u_I, and P_I, complemented by the parameters of their polarization curves, P_{min} and A/2, and also by the results of harmonic analysis of the curves, q_0, u_0*

Name of the star	q_0(%)	u_0(%)	q_I(%)	u_I(%)	P_I(%)	$P_{min.}$(%)	P*(%)	A/2(%)	Source
CQ Cep	-3.10	4.05	-1.00 ± 0.43	2.77 ± 0.18	2.94 ± 0.32	4.80	2.46	0.37	(1)
	-3.27	5.16	(22 stars	in zone	$R = 2°$)	5.30	4.00	0.90	(2)(1994)
	-2.97	4.25				4.75	2.46	0.60	(2)(1996)
	-2.58	4.27				4.60	2.18	0.35	(3)
CX Cep	-0.02	6.15	-0.27 ± 0.25	4.05 ± 0.49	4.06 ± 0.51	6.00	2.11	0.15	(4)
	-0.13	7.04	(8 stars	in zone	$R = 2°$)	6.60	3.00	0.44	(5)
V 444 Cyg	0.18	-0.37	0.47 ± 0.21	0.73 ± 0.28	0.87 ± 0.35	0.25			(6)
			(17 stars	in zone	R=45′)				
			0.04 ± 0.04	-0.24 ± 0.04	$0.24 = \pm 0.04$				(6)
HDE 311884	-3.19	2.87	-1.87 ± 0.41	0.33 ± 0.18	1.90 ± 0.59	3.95	2.86	0.35	(7)(ESO)
	-2.98	2.87	(15 stars	in zone	$R = 2°$)	3.85	2.77	0.30	(7)(San Juan)
HD 211853	0.15	4.10	-0.51 ± 0.13	3.06 ± 0.27	3.10 ± 0.29	4.00			(8)
	0.05	3.90	(21 stars	in zone	$R = 2°$)	3.70			(9),(10)
						2.90			(10)
HD 97152	-0.53	-0.54	-0.48 ± 0.23	-0.14 ± 0.10	0.50 ± 0.25	0.55			(11)
			(20 stars	in zone	$R = 1°$)				
HD 90657	—	—	0.07 ± 0.34	-0.97 ± 0.30	0.97 ± 0.32				(12)
			(14 stars	in zone	$R = 1°$)				
HD 152270	-0.32	-0.22	0.03 ± 0.13	0.76 ± 0.19	0.76 ± 0.20	0.14			(11)
			(27 stars	in zone	$R = 1°$)				
HD 186943	0.74	0.65	0.13 ± 0.41	1.19 ± 0.41	1.20 ± 0.50	0.85			(8)
			(14 stars	in zone	$R = 2.°5$)				

References for the Table 4:
(1) Drissen et al 1986, (2) Kartasheva et al. 1998, (3) Kartasheva et al. 2000, (4) Kartasheva 2002a, (5) Kartasheva 2002c, (6) Robert et al. 1990, (7) Moffat et al. 1990, (8) St.-Louis et al. 1988, (9) Polyakova 1993, (10) Kartasheva 2002b, (11) St.-Louis et al. 1987, (12) Moffat and Seggewiss 1987.

The values $\tau_0 G, \tau_0 H$ and A_p for the systems with a common envelope in a quiescent state are close to the upper limits of these intervals. Our conclusions about the sharp variations of the parameters G and H for CQ Cep and CX Cep when they pass from the quiescent state to excited and back were based on the assumption of approximate constancy of the value τ_0 with time for the envelopes of these systems.

4.3. Analysis of the constant components of polarization of the investigated WR binary systems

Table 4 presents the estimates of the polarization constants (q_0, u_0) derived for the investigated systems from the harmonic analysis of their polarization curves (columns 2 and 3). In columns 4–6 are listed the values of the parameters of interstellar polarization (q_I, u_I, P_I) in the direction of each of the stars. We determined them by means of studying the polarizing ability of the matter (P/A_V) in the neighbourhood of the systems. The procedures described in the papers by Polyakova (1974, 1976) and Abramian (1982) was employed. The data on the neighbouring stars (P, Θ, A_V and $(v_0 - M_V)$) were borrowed from the catalog of Mathewson et al. (1978). It was assumed that the interstellar extinction (A_V) found from the color excess ($A_V = 3E_{B-V}$) could be burdened by the absorption in the WR envelope. For this reason, A_V in the direction of each of the systems was found by the distance module known for the system from the relation $A_V - (v_0 - M_V)$ derived for the neighbouring stars. In brackets, under the values of the parameters of the interstellar polarization, the number of the stars involved in the study and the radius of the zone to which they belong are indicated. The errors of determining q_0 and u_0 are not presented in the table because they are two orders of magnitude as small as those of determination of the interstellar polarization parameters. In the 7th column are given the values of P_{min} for the polarization curves of

Table 5: *Comparison of the estimates of interstellar absorption obtained for the systems from the color excess and from the distance module using the relationship $A_V - (\mathrm{v}_0 - M_V)$ plotted from the neighbouring stars*

Name of the star	$A_{V(E)}$	$A_{V(I)}$	ΔA_V
CQ Cep	$2\overset{m}{.}28$	$2\overset{m}{.}09 \pm 0\overset{m}{.}09$	$-0\overset{m}{.}01 \pm 0\overset{m}{.}17$
	1.28		
	(2.08 ± 0.14)		
CX Cep	3.56	2.61 ± 0.25	0.79 ± 0.29
	3.23		
	$(3.40 \pm 0.14$		
V444 Cyg	2.47	2.52 ± 0.19	-0.19 ± 0.24
	2.18		
	(2.33 ± 0.14)		
HDE 311884	3.71	1.25 ± 0.14	2.40 ± 0.20
	3.60		
	(3.65 ± 0.14)		
HD 211853	2.43	1.90 ± 0.10	0.27 ± 0.17
	1.91		
	(2.17 ± 0.14)		
HD 97152	1.42	1.37 ± 0.11	-0.21 ± 0.18
	0.90		
	(1.16 ± 0.14)		
HD 90657	2.28	1.67 ± 0.14	0.56 ± 0.20
	1.95		
	(2.11 ± 0.14)		
HD 152270	1.31	1.58 ± 0.09	-0.35 ± 0.17
	1.16		
	(1.23 ± 0.14)		
HD 186943	1.74	1.99 ± 0.24	-0.54 ± 0.28
	1.31		
	(1.53 ± 0.14)		
HD 92740	0.83	1.39 ± 0.10	-0.50 ± 0.17
	0.94		
	(0.88 ± 0.14)		
HD 193793	2.18	1.82 ± 0.14	0.28 ± 0.20
	2.03		
	(2.10 ± 0.14)		
HD 193928	3.67	2.50 ± 0.20	1.12 ± 0.24
	3.57		
	(3.62 ± 0.14)		

the discussed WR binary systems. These values must be approximately equal to P_I in the absence of additional contributors to the constant components of polarization of the systems. Such is the situation in the majority of the examined systems. The interstellar polarization in HD 152270 exceeds essentially not only the value of P_{min} but also P_{max}, which should not happen. Probably, a local drop of the interstellar extinction takes place in the region of HD 152270, which is confirmed by the data of Table 5. In the case of HD 211853, only the value of $P_{min} = 2.9\,\%$ obtained in our observations of the system in 1999 (Kartasheva 2002b) approximately reaches the value of P_I. The fact that in the observations of this system by St.-Louis et al. (1988) and Polyakova (1993) P_{min} is much higher than the interstellar polarization value in its neighbourhood is a consequence of the sharp increase of P for HD 211853 at the phases of conjunction, when the O star is at the front. The latter is likely to be associated with the brightness decrease (unpolarized light) of the O companion as a result of appearance of a temporary envelope round it. Only for three of the WR binary systems with a common envelope, CQ Cep, CX Cep and HDE 311884, a considerable excess of P_{min} over P_I is caused by the rise of the entire polarization curve. For the three systems with a common envelope the 8th column of Table 4 presents $P_0{}^*$, the values of the constant components of polarization P_0 free from the contribution of the interstellar polarization P_I:

$$P_0{}^* = [(q_0 - q_I)^2 + (u_0 - u_I)^2]^{1/2}.$$

Column 9 lists the values of half-amplitudes of the polarization curves of these three systems. From a comparison of the data of columns 8 and 9 of the table it can be seen that the value of additional contributors in the constant components of polarization of the systems with a common envelope is very large. Being independent of the orbital period phase, this additional contributors shows considerable time variations and is likely to arise in the outer layers of common envelopes of these three systems. Thus, the examination of the constant components of polarization of WR binary systems of different degree of closeness confirm our conclusions about the feature of the long-term behaviour of P of the closest of them having a common envelope. Not so close system as HD 311884 ranks among the latter ones because of the high mass of the WR component.

Table 5 shows additional and, in our opinion, useful information about the estimates of the interstellar absorption found for the system from the color excess, $A_{V(E)}$, (column 2) and from the neighbouring stars, $A_{V(I)}$, (column 3). $A_{V(E)}$ were derived from the estimates of interstellar absorption borrowed from the catalog of Van der Hucht et al. (1988) (first line), the catalog of Conti and Vacca (1990) (second line) and transformed to Johnson's system. The catalog estimates of the accuracy of determination of $A_{V(E)}$ are equal to $\pm 0\overset{m}{.}2$. The third line of column 2 gives the average value $A_{V(E)}$ of the two catalogs and the error of its determination. We obtained $A_{V(I)}$ by the procedure described at the beginning of this section. The 4th column presents the differences $\Delta A_V = A_{V(E)} - A_{V(I)}$. For nearly all the investigated stars the values ΔA_V turned out to be within the determination errors, 3σ, which evidences that no noticeable absorption of light occurs in the envelopes of "ordinary" WR stars. The difference in ΔA_V turned out to be real and large only for HDE 311884. This confirms once again that the system has a very massive WR component with an extensive envelope. The latter induced us to add the table by three more WR binary systems, not investigated polarimetrically yet (HD 92740, HD 193793 and HD 193928). In all the three systems very massive WR components are supposed (Cherepashchuk 2001). As is seen from the addition to Table 5, the absorption excess has not been found in the first two systems. ΔA_V is significant for HD 193928, but twice as small as the absorption excess found in HDE 311884. Thus, it can be suspected that HD 193928 contains a WR component more massive than ordinary WR binary systems.

4.4. On the relation of the long-term polarization behaviour of WR binary systems with the degree of their closeness

Table 6 gives physical characteristics of WR systems, whose long-term variations of the linear polarization have been studied by us or analysed from literature data. Along with the values of the orbital period of the system, P, spectral classification of the components, Sp, the values of the orbit inclination, i_{pol} and i_{phot}, the component masses, m_{WR}, m_O, and their ratios, $q = m_{WR}/m_O$, the table presents the estimates of the distances between the component centres, $a = a_{WR} + a_O$, and also the values of parameter y_{12}, which show the dimensions of the ICL of the WR stars in y coordinate. The latter were taken from the paper by Plavec and Kratochvil (1964) and are expressed in solar radii.

In the second section of the paper, proceeding from the analysis of long-term polarization investigations of four close WR binary systems, CQ Cep, CX Cep, HD 211853 and V444 Cyg, we assumed the existence of the relationship between the character of the long-term behaviour of polarization of these stars and the degree of their closeness. In this connection four situations were considered, i.e. four possible correlations between the sizes of the WR-envelope in a quiescent and excited states and the size of the ICL of the WR star. In two of these situations (2nd and

Table 6: *The physical characteristics of the investigated WR binary systems*

Name of the star	P (days)	Sp	i°	m_O	m_{WR}	q	a ($R_\odot$)	y_{12} ($R_\odot$)	Source
(HD214419) CQ Cep (WR 155)	1.64	WN7+O9	68 ($\bar{i}_{phot.}$)	17.7	14.7	0.83	18.7	6.7	(1)+(2)
CX Cep (WR 151)	2.13	WN6+O8V	53.9 ($i_{pol.}$)	23.1	10.0	0.43	22.4	6.7	(3)+(4)+(5)
(HD 193576) V444 Cyg (WR 139)	4.21	WN5+O6	78.7 ($i_{pol.}$)	27.9	9.3	0.33	36.6	10.2	(6)+(7)
HDE 311884 (WR 47)	6.34	WN6+O5	70 ($i_{pol.}$)	56.6	48.2	0.84	68.0	24.5	(8)+(9)
(HD211853) GP Cep (WR 153)	6.69	WN6+O7V	74 ($i_{phot.}$)	25.0	11.1	0.44	41.6	12.5	(10)+(11)+(14)
HD 97152 (WR 42)	7.86	WC7+O7V	43.5 ($i_{pol.}$)	18.7	11.0	0.59	51.8	17.1	(12)+(13)
HD 90657 (WR 21)	8.26	WN4+O4-O6	56.6 ($i_{pol.}$)	37.0	17.0	0.46	60.0	18.6	(15)+(16)
HD 152270 (WR 79)	8.89	WC6-7+ +O5-6	44.8 ($i_{pol.}$)	14.0	5.1	0.36	48.2	14.0	(12)+(17)
			33.6 ($i_{phot.}$)	28.9	10.6		61.3	17.8	(14)+(17)
HD 186943 (WR 127)	9.55	WN4+O9V	55.7 ($i_{pol.}$)	34.9	16.5	0.47	69.7	21.6	(10)+(18)

References for the Table 6:
(1) Kartasheva et al. 2000, (2) Kartasheva and Snezhko 1985, (3) Schulte-Ladbeck and Van der Hucht 1989, (4) Kartasheva 2002a, (5) Massey and Conti 1981, (6) Robert et al. 1990, (7) Marchenko et al. 1994, (8) Niemela et al. 1980, (9) Moffat et al. 1990, (10) Massey 1981, (11) Kartasheva 2002b, (12) St.-Louis et al. 1987, (13) Davis et al. 1981, (14) Lamontagne et al. 1996, (15) Niemela and Moffat 1982, (16) Moffat and Seggewiss 1987, (17) Seggewiss 1974, (18) St.-Louis et al. 1988.

4th) during the enchanced activity of the WR star, conditions are created for light variations (unpolarized light) of the O companion (and in the 4th of both companions), which leads to amplitude variations of the polarization curves. In two other situations (1st and 3rd), the enchancement of the activity of the WR star is not accompanied by brightness variations of the O companion, and no long-term variations of P must be observed in this system. To make the picture complete, and, therefore, to corroborate the assumption made, we were lacking in WR systems in which situation 1 would be realized, i.e. wider "WR+O" pairs showing time constancy of the polarization curves. Having detected the absence of long-term variations of P in two wider systems, HD 155270 and γ^2 Vel, (section 3), we thus proved qualitatively the correctness of the above mentioned assumption. Using the data of Table 6, we made an attempt to prove further the correctness of our assumption quantitatively. Indeed, if the relation between the long-term behaviour of P of the considered systems and the degree of their closeness or the degree of filling by the WR-envelopes of the ICL of their stars does exist, then the values y_{12} derived for V444 Cyg and

HD 155270 allow rough restrictions to be imposed on the sizes of WR-envelopes in the quiescent and excited states:

$$R_{WR\,envel.\,quiet} > (y_{12})_{V444\,Cyg} \approx 10R_{\odot},$$
$$R_{WR\,envel.\,excite} < (y_{12})_{HD\,152270} \approx 14 - 18R_{\odot}.$$

The criterion of filling by stars their ICL, i.e. when the star radius reaches the size of the ICL in y-coordinate (the value y_{11} for more massive component and y_{12} for less massive) (see Plavec & Kratochvil 1964), was used as the filling criterion by the WR-envelopes of the ICL of their stars. Restrictions derived for WR-envelope sizes are in good agreement with currently accepted estimates of their sizes, $20 - 30R_{\odot}$, (Kron and Gordon 1950; Kuhi 1968; Hanbury Brown et al. 1970; Cherepashchuk 1996). Comparing these restrictions with the estimates of y_{12} for CQ Cep, CX Cep and HD 211853 (see Table 6), we see that the situation with CQ Cep and CX Cep corresponds, indeed, to situation 4 considered in section 2, whereas in the WR binary, belonging to HD 211853, the WR-envelope in an excited state is actually on the verge of overfilling the ICL of the WR star (situation 2). Thus, a whole picture is obtained requiring, however, the refinement of the threshold value of the orbital period at which the WR-envelope in the quiet and excited states is within the ICL of its star. This, in turn, will lead to the refinement of the sizes of the WR-envelope in the excited state.

5. Conclusions

New evidence for the nonstationary of matter outflow from the extended envelopes of WR stars has been obtained. Investigations of the long-term behaviour of linear polarization of WR binary systems have not only corroborated our conclusions about the episodic expulsion of the outer parts of WR-envelopes, which follow from photometry, spectroscopy and study of (O-C) diagram of the closest of WR binary systems, CQ Cep (Guseinzade 1969; Kurochkin 1979; Kartasheva 1987; Kartasheva and Svechnikov 1996; Kartasheva and Snezhko 1985; Kartasheva and Svechnikov 1991), but also exposed some concrete details of the process of mass loss by WR stars. It has been found that the expulsion of the outer parts of WR-envelopes is preceded by their swelling, that is the inflow of additional matter (the growth of n_e is 2–3 times). The expulsion phase itself continues, probably, not less than a year (the disappearance of the first maximum on the polarization curve of CQ Cep, which we noted in the 1996 June–September observations, took place in the observations of Harries and Hilditch (1997) carried out in 1995 August). Since during six years of our rather rare polarization observations, we have recorded in three WR binary systems per one phase of expulsion (CQ Cep and HD 211253) and the swelling phase of WR-envelope preceding it (CQ Cep and CX Cep), it can be concluded that this phenomenon is not infrequent for WR stars. New results of polarimetric investigations of WR binary systems complemented with the details following from photometry, spectroscopy and investigation of (O-C) diagram of CQ Cep will make it possible to give rather a complete observational picture of the mass loss by WR stars, on the one hand, and to solve many enigmas of the closest of WR binary systems, CQ Cep, on the other hand.

It is worthwhile to say separately about HDE 311884. Three proves of the existence of a common envelope in the system are presented in this paper: 1) the "mirror" shape of its polarization curve with respect to the light curve; 2) the detection of considerable additional absorption ($\Delta A_V = 2^{\rm m}\!.4 \pm 0^{\rm m}\!.20$); 3) the detection of a significant additional contributor to the constant component of polarization. Since the system is not so close (P = $6^{\rm d}\!.69$) the existence of a common envelope in it can be explained only by high massivity of its WR component. The system needs to be investigated both polarimetrically and spectroscopically.

The attempt to detect additional absorption, ΔA_V, for other three systems, the WR components of which are supposed to be high massive, HD 92740, HD 193793 and HD 193928, has led to the confirmation of the supposition only for the last of them ($\Delta A_{V(HD\,193928)} = 1^{\rm m}\!.1 \pm 0^{\rm m}\!.24$).

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