FEATURES OF THE WAVE-LIKE DISTORTION IN SOME RS CVn BINARIES

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One of the outstanding features of RS CVn-type binaries is the changing shape of the so called "wave-like distortion" or "photometric wave" (PW) and its phase migration on the light curve (LC). Here we present a preliminary analysis of the observations of the following objects: CQ Aur, RU Cnc, VV Mon and SZ Psc. For each system we have derived the amplitude and phase of the PW maximum and its migration rate.

Typically, the PW of RS CVn systems can be represented by: $\ell = \ell_0 + \ell_w \cos(\phi - \phi_{max})$. However, this equation applies to an ideal situation, while other effects, such as ellipticity and reflection, modify the LC of binary systems. In general we may adopt the truncated Fourier expansion: $\ell = A_0 + A_1 \cos\phi + B_1 \sin\phi + A_2 \cos(2\phi)$, but higher order terms cannot be excluded. The coefficient A_2 allows for the usual ellipticity effect and for a possible asymmetry of the PW, whereas A_1 is due, at least in part, to the reflection effect. Therefore, if we want to find out the features of the PW, we need to assume preliminary estimates of ellipticity and reflection effects. The reflection effect has been estimated theoretically from the spectral type of the components. Owing to uncertainties in this determination we have considered several possible values. In all cases the general behaviour is not significantly altered. We have assumed symmetric PWs, i.e. the coefficient A_2 is due only to ellipticity. This hypothesis was confirmed "a posteriori", as generally concordant A_2 values for all the available LCs of each binary were found. Therefore, we adopted the average values of the ellipticity coefficients found in different years. The results of our analysis for each system follow.

a) CQ Aur is an example of a binary whose LC is modified both by the PW and by reflection and ellipticity effects (Fig. 1). In this case the Fourier expansion gives concordant values of A_2 for all years (~ 0.03), whereas a rather small value (~ 0.001) was found for the reflection

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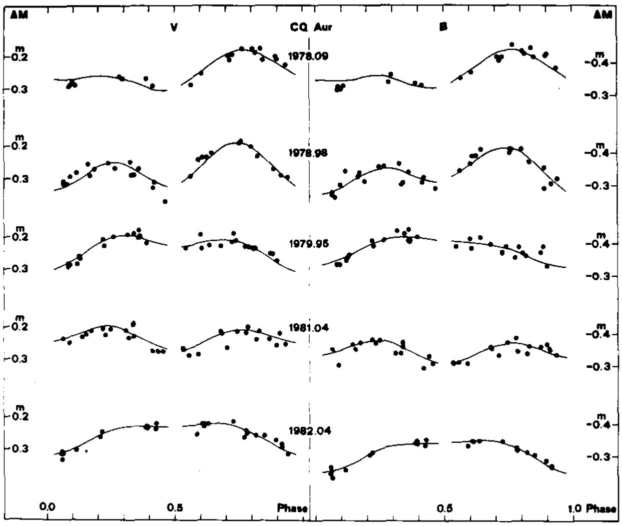

Figure 1. Seasonal V and B light curves of CQ Aur

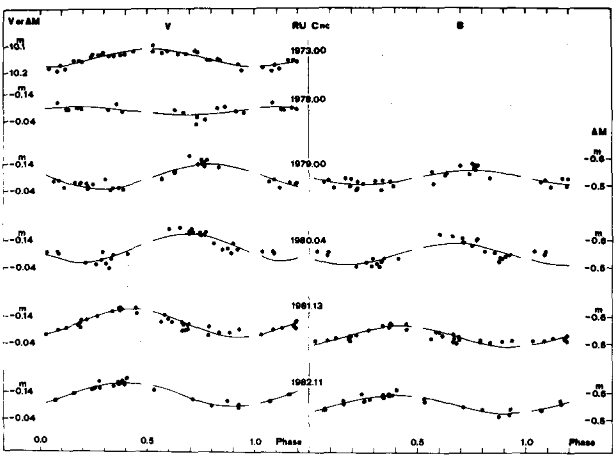

Figure 2. Seasonal V and B light curves of RU Cnc

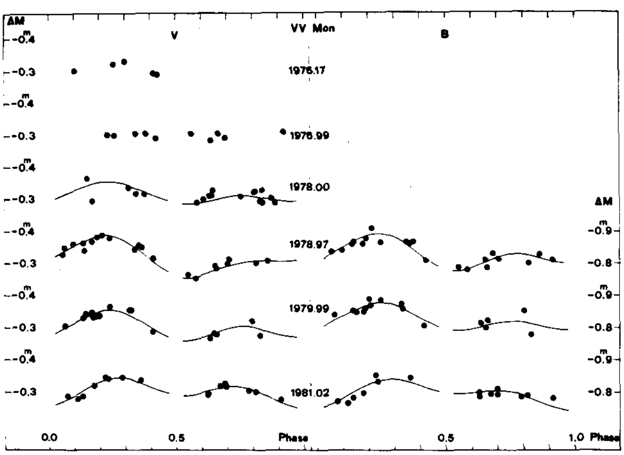

Figure 3. Seasonal V and B light curves of VV Mon

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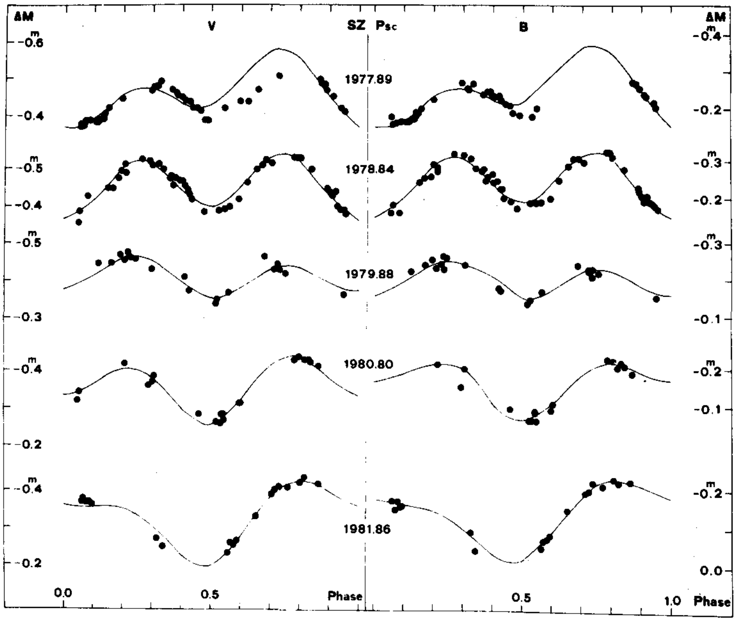

Figure 4. Seasonal V and B light curves of SZ Psc

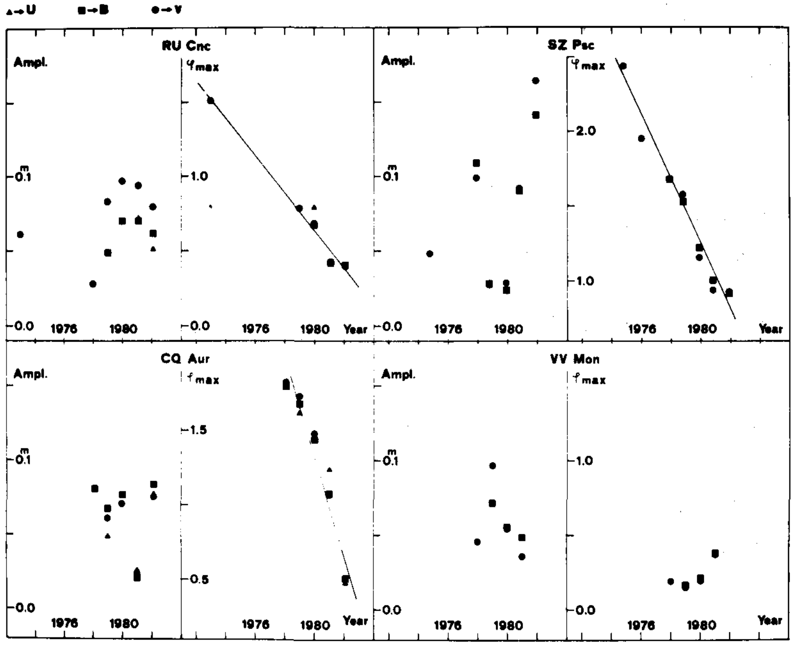

Figure 5. Amplitudes of the photometric wave and migration of the maximum phase (ϕ_{max}) on the light curve of RS CVn binary systems versus time.

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coefficient. By assuming for the latter an higher value (-0.004) we find a variation of $0^P.01$ - $0^P.02$ in ϕ_{max} and of only a few thousands of magnitude in the amplitude. In the interval covered by our observations the amplitude of the PW varies in a rather erratic way, while its backwards motion leads to a migration period of 3.0 ± 0.2 years.

b) The RU Cnc out-of-eclipse LC closely resembles that of RS CVn itself. In this case the PW is probably superimposed to a nearly flat maximum (Fig.2) A Fourier expansion including A_2 leads to small values of this term with a mean value around zero. Therefore, being negligible the reflection and ellipticity effects, a pure sinusoidal PW was adopted. We found variable amplitude attaining 0.1 mag at most and being smaller in blue than in yellow light. Actually the PW disappeared in 1977-78 leaving a nearly flat LC. Assuming a uniform wave migration towards decreasing orbital phase, we find P(migr) = 7.9 ± 0.4 years (Fig. 5).

c) VV Mon represents a different case with respect to CQ Aur and RU Cnc because neither pure sinusoidal PW nor definitely distorted rounded maxima are apparent on the available LCs (Fig.3). The reflection coefficients we adopted were -0.050 and -0.010, whereas the Fourier analysis of the LCs gives concordant values of A_2 for all observing seasons. The average value A_2 = -0.025 was adopted. The uncertainty we found by changing the reflection coefficients are ~ 0.03 in ϕ_{max} and ~ 0.01 in the PW amplitude. No definite trend in the variation of the PW amplitude is apparent, whereas the phase shift of its maximum seems to indicate a change in the sense of migration. Hence, it is not possible to estimate the migration period.

d) The case of SZ Psc is similar to that of CQ Aur. The adopted reflection coefficients are -0.002 and -0.004, whereas the coefficient A_2 turns out to be fairly constant, but in the season 1978-79. Again we adopted an average value for A_2 (-0.045). Combining our data with other previous results, we have obtained a backwards motion of the PW with a migration period of 4.6 ± 0.3 years (by assuming a uniform rate) whereas its amplitude varies in a more complicated way. It is interesting to notice that the minimum of the PW amplitude occurred at the time of the Hα outbursts observed by Bopp (1981). The available LCs are shown in Fig. 4.

Further photoelectric observations are planned in order to achieve a more complete picture of the LC variations and of the physical phenomena involved.

REFERENCE

Bopp, B.W.: 1981, Astron.J. 86, 771.