LONG–TERM ACTIVITY CHANGES OF UV PISCIUM

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ABSTRACT. UV Psc has been observed since 1976 at the Ankara and Ege University Observatories. Mean light curves in B and V colours obtained using the maxima levels of observed light curves of the system. Assuming this light curves as the least active ones, the orbital parameters of the system have been obtained using the Wilson–Devinney code. The radial velocity curves of both components have been used during the solution. Wave–like distortion curves for each year have been obtained subtracting the theoretical light curves from the observed ones. Using these curves, the spot parameters have been roughly determined and finally, spotted light curve solutions and the accurate spot parameters have been obtained. Activity and colour behaviour were examined.

Key words: Stars: binaries: close-stars: individual (UV Psc) - stars: variable

Introduction

Chromospherically active RS CVn type eclipsing binary UV Psc (BD +6°189) has been observed since 1976 at the Ankara and Ege University Observatories. It shows wave–like distortions in its light curves like other RS CVn systems. These systems have variable mean–brightness and period.

All the data obtained at both observatories were transformed to standard UBV system and combined. During the observations BD +06°191 and BD +06°197 were used as comparison and check stars, respectively. In Figs. 1 and 2, all the data obtained at both observatories are given. The maxima of the light curves are seen as a thick band due to the migration of the wave–like distortion. Because the position of the maximum and minimum of this distortion are in different phases in each years' light curve.

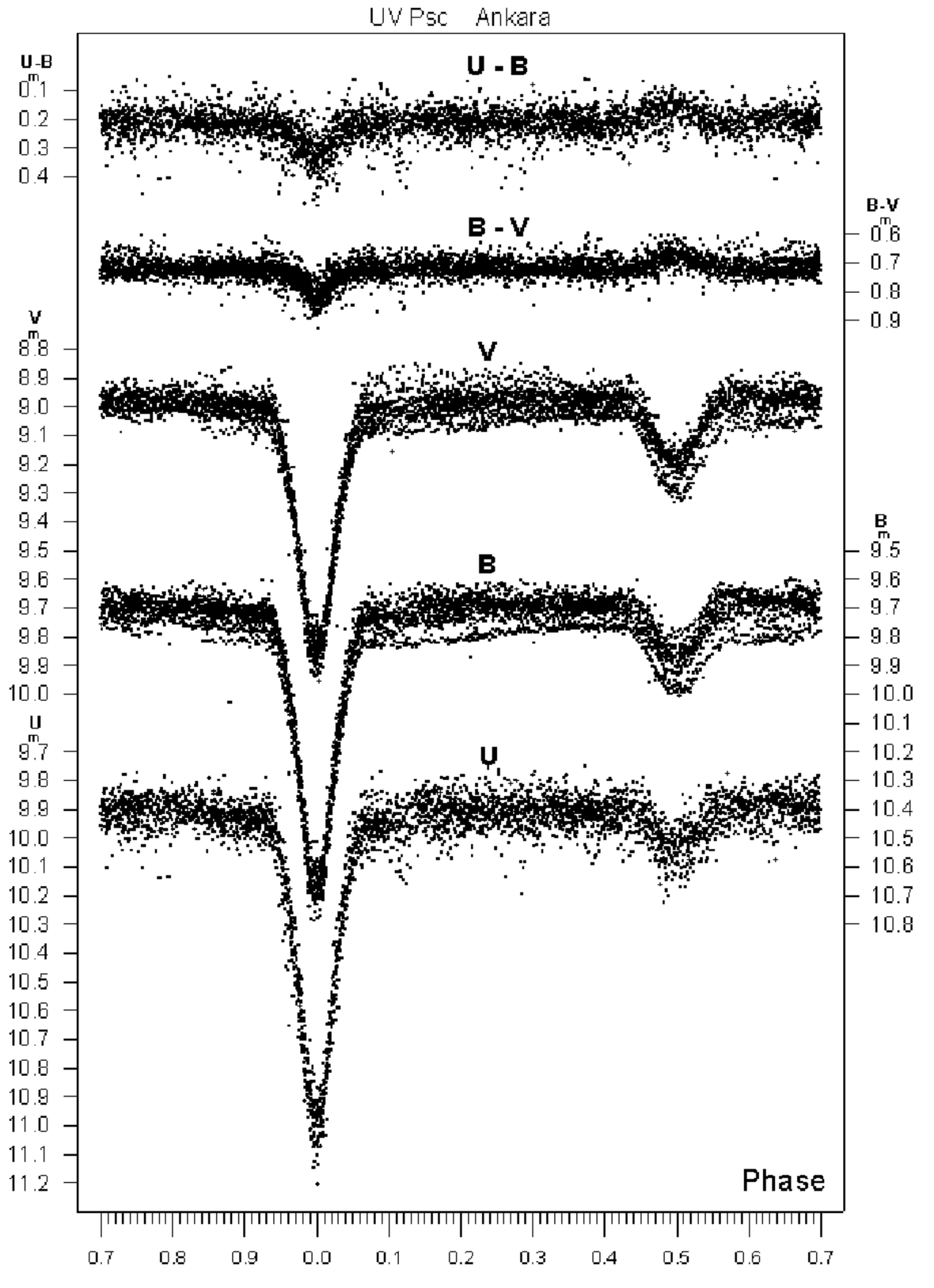

Figure 1: U, B and V light curves of UV Psc obtained at the Ankara University Observatory.

In this study, our aim was to analize the light curves of the system in B and V colours and to determine the positions of the spots caused the wave–like distortions of light curves. If one can determine the spot parameters on one of the component star's surface, activity cycle of the system can be determined if it has any periodicity. If the orbital parameters of the sy-

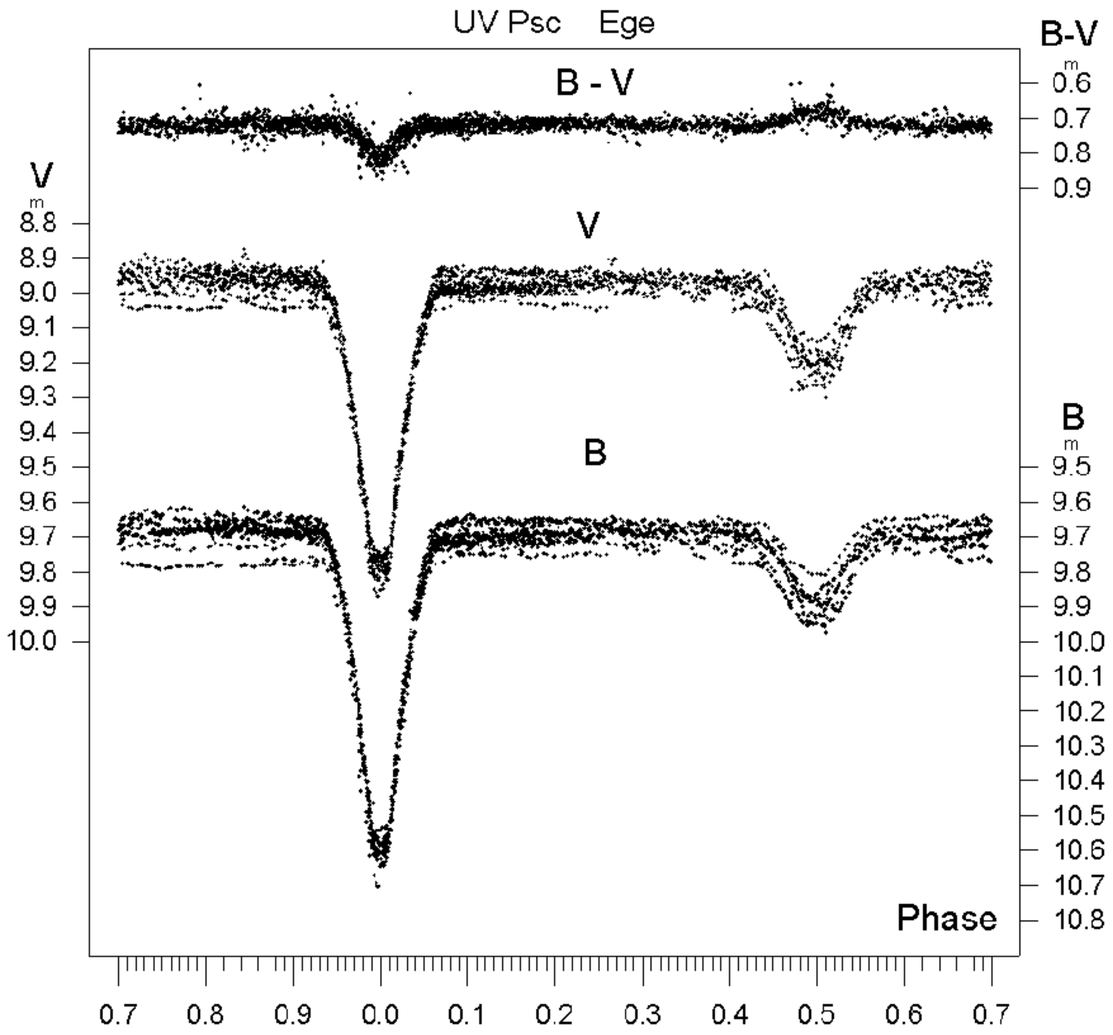

Figure 2: U, B and V light curves of UV Psc obtained at the Ege University Observatory.

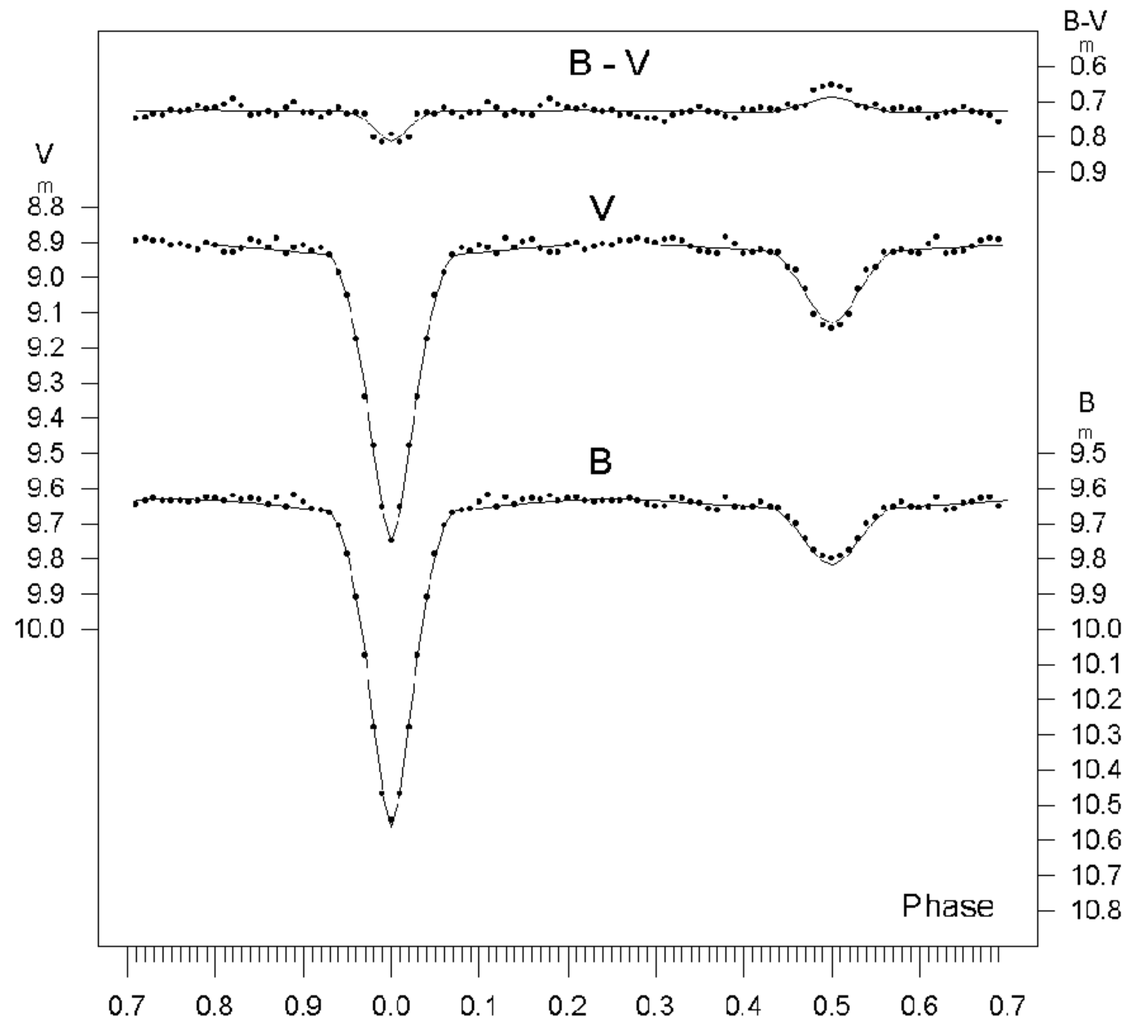

Figure 3: B and V mean light curves and B−V mean colour curve of UV Psc. Theoretical curves are also drawn onto the observed curves.

stem are known, the theoretical light curve can be calculated, and subtracting this light curve from the observations, parameters for the activity and variation can be determined from these differential curves.

Light Curve Solution

Generally, one or more spots are located on one of the components (generally on cool component) of RS CVn type systems and they changes with time. Effects of these spots generally are seen at the maxima of light curves. So, the shape of each obtained light curve is different from the others. In order to determine the activity of the system, first of all, eclipses and the proximity effects should be known. This can be done only determining the orbital parameters of the system solving the light curves.

In order to compare each light curves to others, the average brightnesses have been calculated for every 0.01 phase interval for V colour. The maximum brightness values were selected for each phase and the light curve was folded at the 0.5 phase in order to guarantee each point is really the brightest one for each phase value. These values were used as the mean light curve. We supposed that this light curve is the least active one. This procedure was also repeated for B colour.

If a light curve is obtained without the spots (or if this obtained light curve is not affected by the spots), orbital parameters of the system can be determined but such a light curve never could be obtained. Because the activity of these systems are never disappearing. In this case, The least active mean light curve should be supposed as if it has no activity. Otherwise, if we do not make such an approximation, nothing can be determined about the activity of the system and the spots.

For the light curve solution with the Wilson–Devinney code (Wilson and Devinney, 1971), various parameters for the system were collected from the literature and some parameters determined in this study. Radial velocity curves for both components which obtained by Popper (1991) were used. During the solution, only the presence of the proximity and reflection effects were assumed. Table 1. shows the some initial and determined parameters of the system.

With the determined parameters, the theoretical light curves of the system were calculated and drawn with the observed mean B and V light curves in Fig. 3. The B–V colour curve is also included in the figure. These theoretical curves were subtracted from the observed light curves of each year and the vari-

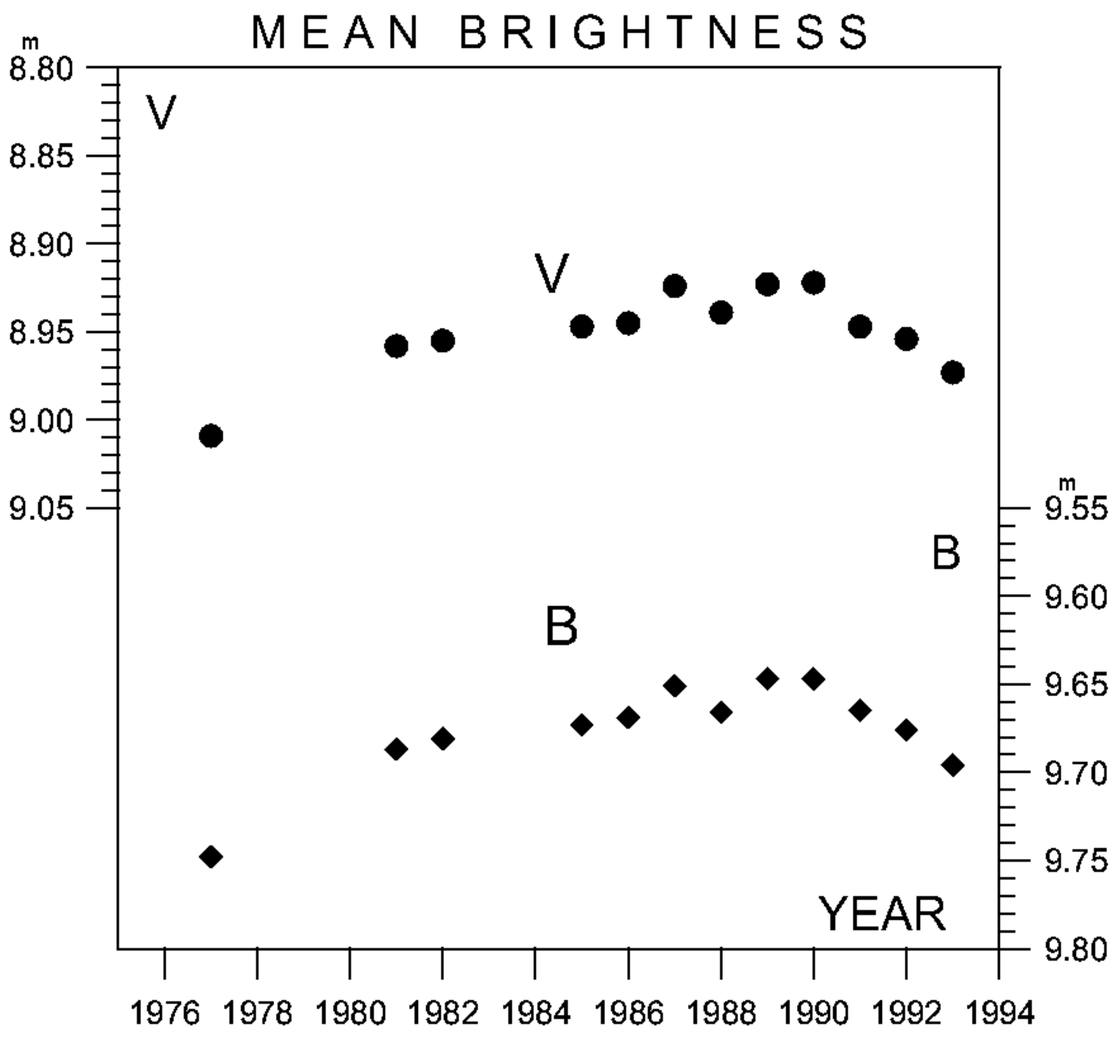

Figure 4: B and V mean brightness versus time.

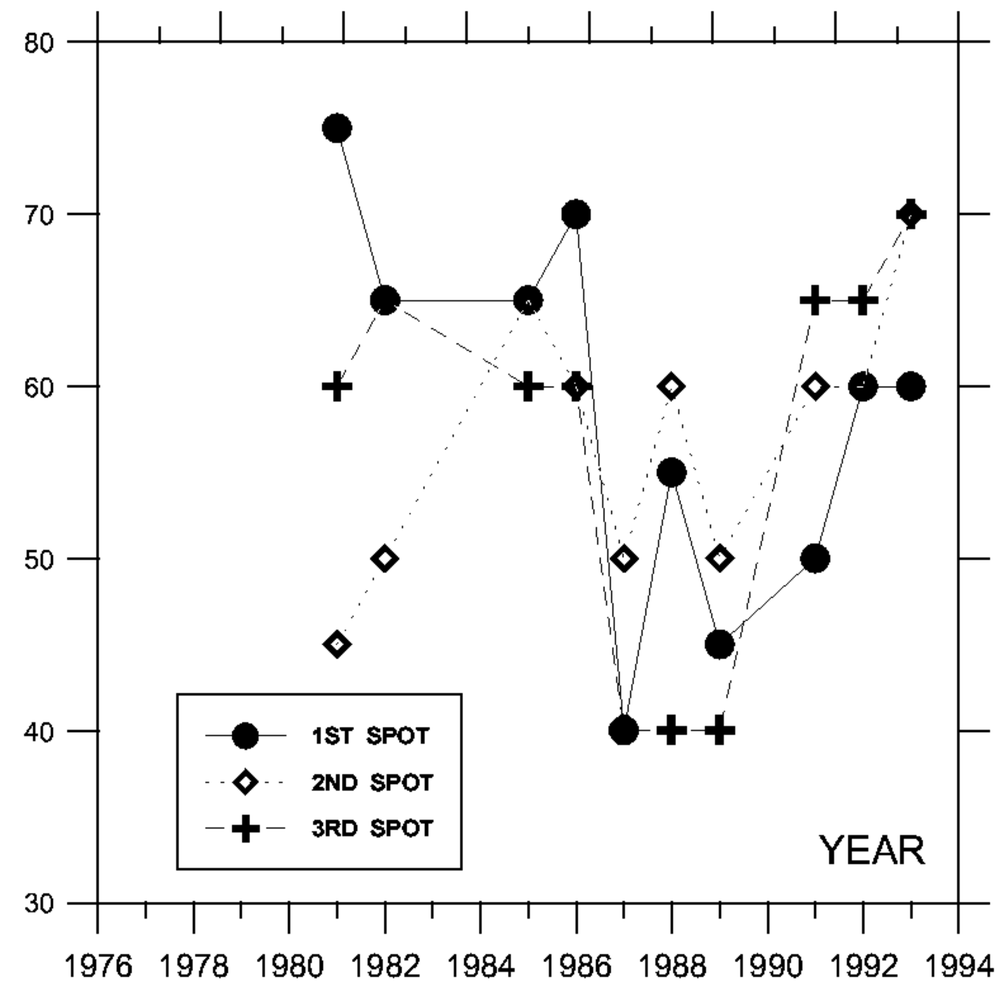

Figure 7: Latitudes of the spots versus time.

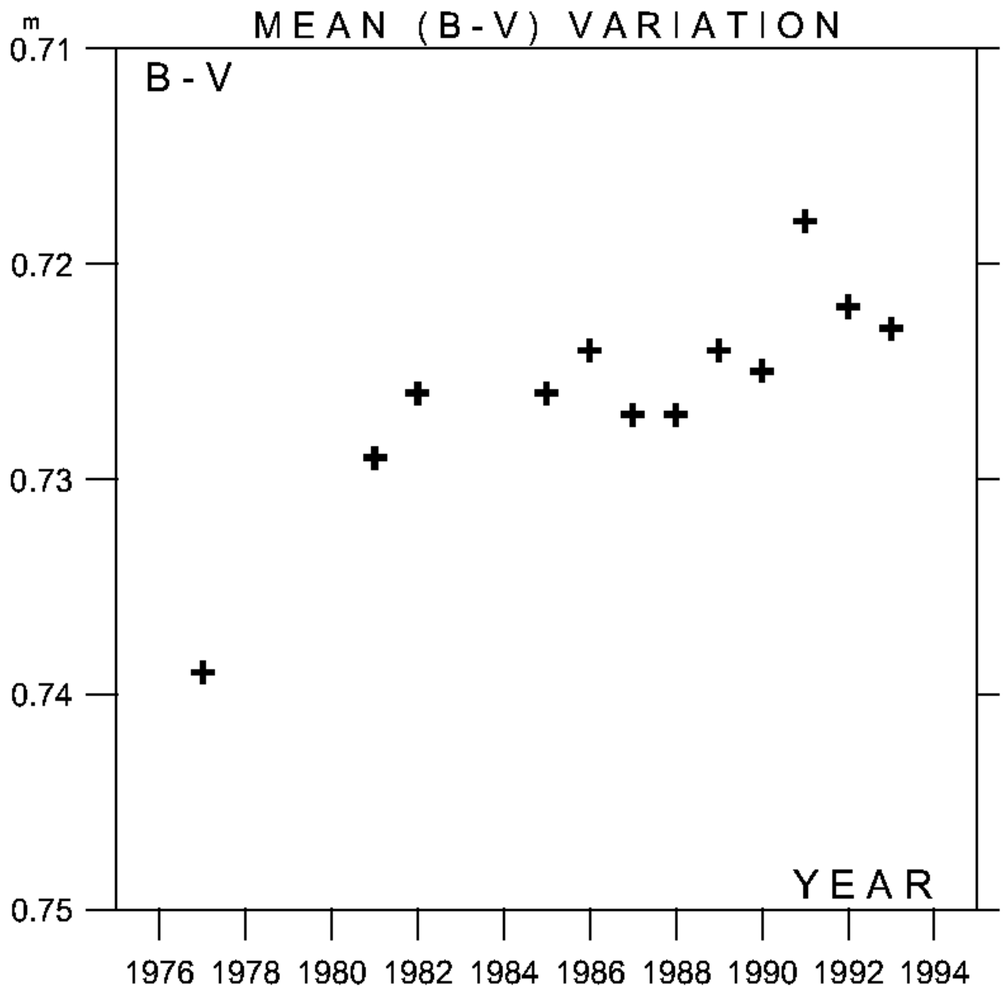

Figure 5: B−V mean colour versus time.

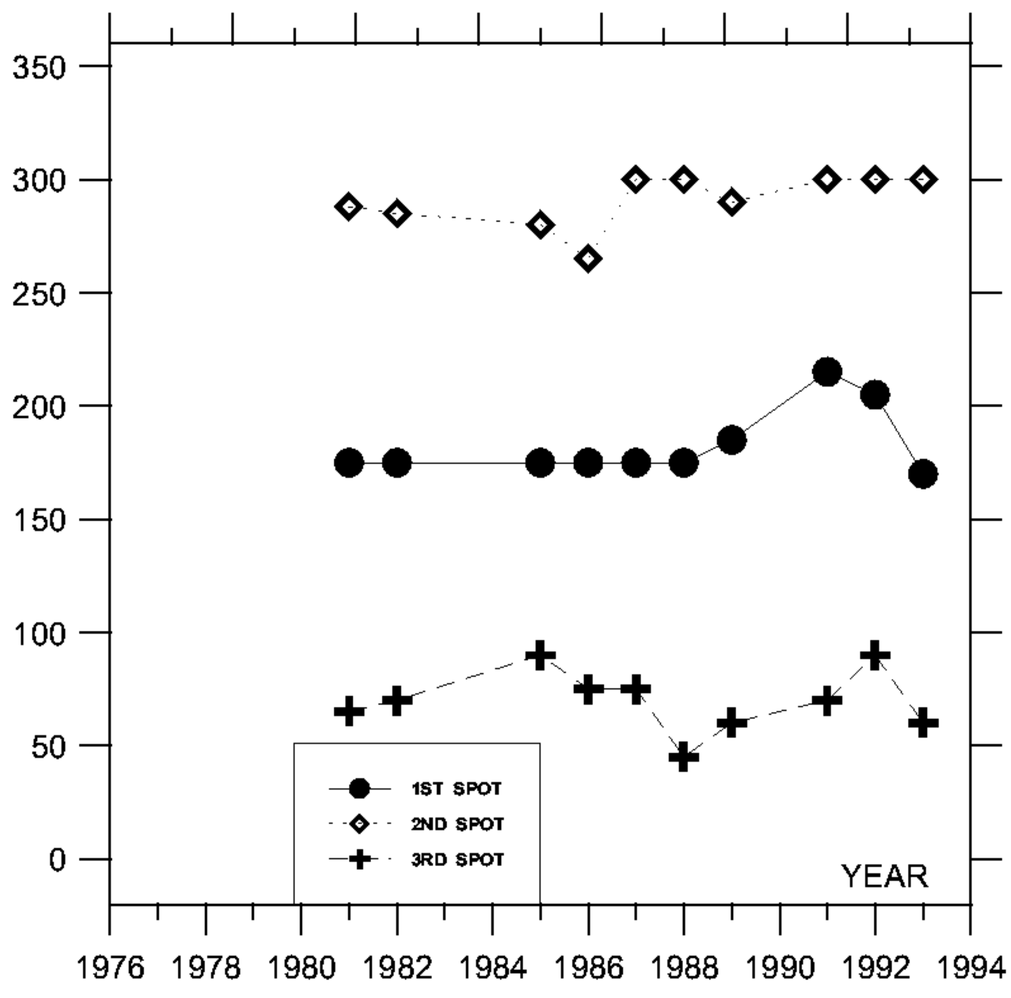

Figure 8: Longitudes of the spots versus time.

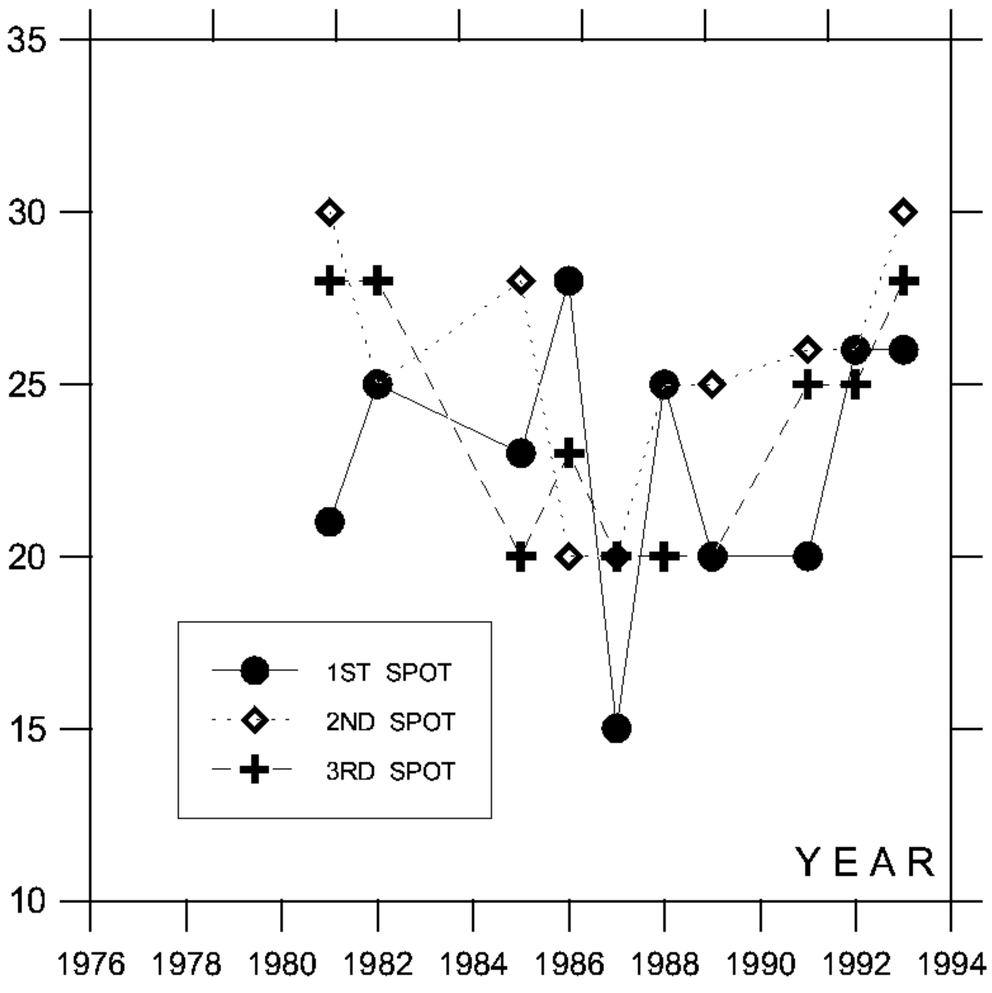

Figure 6: Radius of three spots versus time.

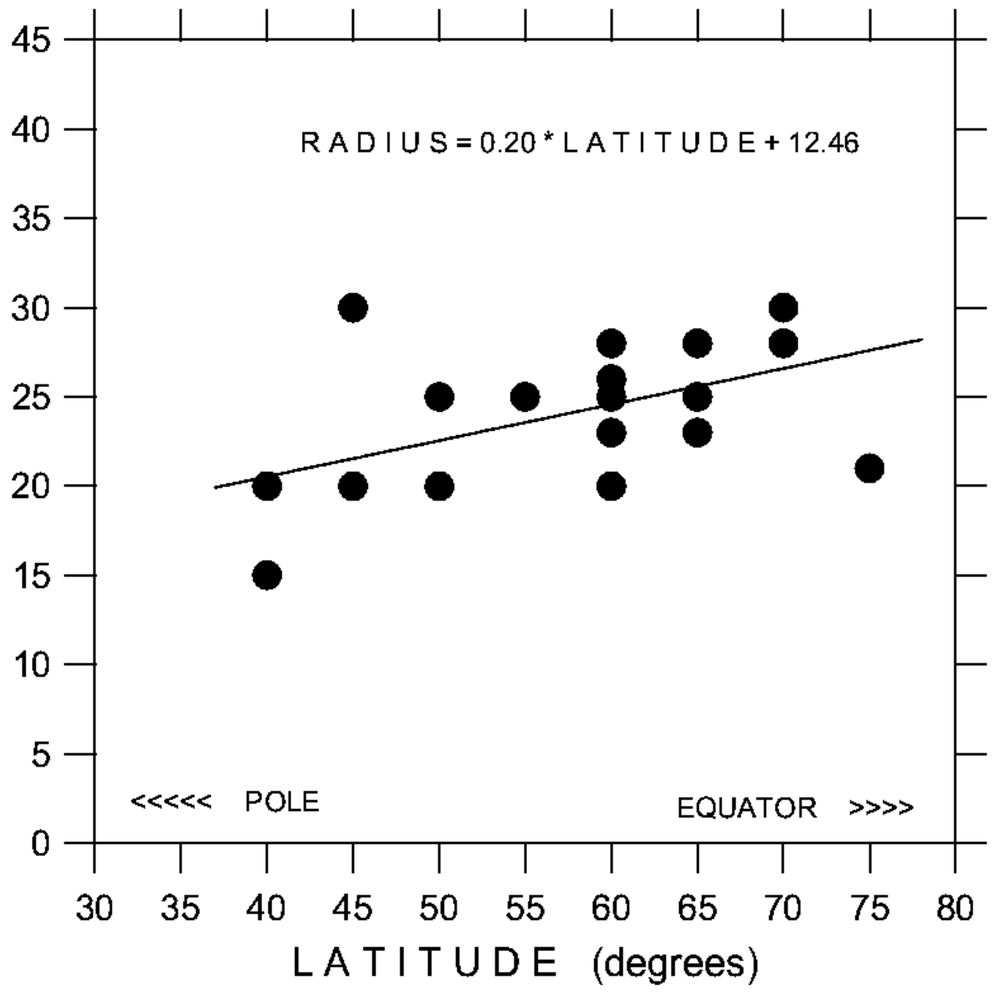

Figure 9: Radius of the spots versus latitudes of them.

Parameter	Initial Value	Final Value
T_h	5740	
T_c	4750	4555±10 K
i	88°	85°310±0.099
q (m_c/m_h)	0.768	
$l_h(B)$		0.872±0.024
$l_h(V)$		0.836±0.025
$l_c(B)$		0.128±0.024
$l_c(V)$		0.164±0.025
r.m.s.		0.00376

Table 1: Some initial and final parameters of UV Psc used in the light curve solution.

ations of the wave–like distortion curves were determined for each year. Assuming the reason of this distortion is one or more spots on one of the components, the numbers, longitudes, latitudes and temperature factors of the spots were roughly determined using these wave–like distortion curves. Using these initial parameters for the spots, the light curve solution of the system repeated and the final spot parameters determined.

Conclusions

UV Psc have been observed for a long time photoelectrically by many investigators but spectroscopic observations are very rare. For a unique light curve, it is very difficult to obtain the maximum light level in order to determine the spot activity. In this study, this was not so difficult since we have 18 years of observations. Figs. 4 and 5 show that the system shows a periodic mean brightness and colour variation. The period of this variation is approximately 8 years.

Fig. 7 shows that while the latitudes of three determined spots change during the activity cycle and the spots migrate to equator untill 1988 and then they migrate to pole, the longitudes of these spots almost remain constant. During the cycle, the radius of these spots also change (Figs. 6, 7) but the periodicity of this change is not similar to latitude change period.

It is necessary to obtain long–term and high resolution spectra of the system in order to support these photometric results. Despite lack of such spectral data, the orbital parameters and the activity changes of the system were determined with sufficient accuracy since we have long–term observations of the system. Future observations of the system will make these results more accurate.

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