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J AND K INFRARED LIGHT CURVES OF THE ACTIVE BINARY BH Vir

ARÉVALO, M. J.[1]; LÁZARO, C.[1]; BARRERA, E.[1]; DOMINGUEZ, R. M.[2];

[1] Departamento de Astrofísica, Universidad de la Laguna, 38271 La Laguna, Tenerife, Spain and Instituto de Astrofísica de Canarias, 38205 La Laguna, Tenerife, Spain. e-mail: mam@ll.iac.es, clh@ll.iac.es

[2] Telescopio Nazionale Galileo, Centro Galileo Galilei, P.O. Box 565, 38700 Santa Cruz de La Palma, Spain, e-mail: domingue@tng.iac.es

We have carried out a monitoring program devoted to the photometric infrared observation of active RS CVn short-period systems (Arévalo, 1994). These binaries display vast solar-type activity phenomena. Over the last two decades efforts have been made to understand the nature of this activity. One aim of these studies has been to model the physical properties of starspots evident from distorted photometric light curves. Once the distortion wave are removed the clean light curves are analyzed with the aim of determining reliable parameters. For this reason it is important to analyze IR light curves in order to determine the physical parameters of these binaries. Light curves observed in the infrared bands have revealed that this spectral region is not exempt from the known variability presented in the visible spectral range, but it seems clear that the amplitude of the observed irregularities in the light curves generally decreases at longer wavelengths (Arévalo, 1994).

Before discussing the results it is interesting to give a summary of some of the known features of BH Vir, currently considered a member of the RS CVn short-period group. Photometric visible light curves have been published regularly since 1957 (See Zeilik *et al.* 1990 and Xiang, Deng and Liu 2000, for references). Zeilik *et al.* (1990) studied all the visible photometric light curves observed from 1953 to 1986 parameterizing the photometric distortion waves presented in the light curves of BH Vir by a dark circular spot model on the primary star. When the starspot contribution was subtracted from the light curves the latter were analyzed in order to obtain the physical parameters. Later Xiang, Deng and Liu (2000) modeled the photometric distortion, also considering active regions on the secondary star. Complete Strömgren *uvby* light curves with the distortion wave removed were analyzed by Clement *et al.* (1997), who concluded that BH Vir appears to be a binary system with G0 and G2 main sequence solar-type stars. There are slight disagreements among the results of the analysis performed by different authors using different fitting programs. Vincent, Piskunov and Tuominen (1993), by means of surface imaging technique, pointed out that BH Vir has a total secondary eclipse.

Concerning spectroscopic mass ratio $q = m_2/m_1$ determination, different authors give different values, ranging from 1.02 to 0.903 (e.g., Abt 1965; Popper 1997; Xiang, Deng and Liu, 2000). From photometric and spectroscopic studies, it seems that the primary component in BH Vir is approaching the end of its main sequence life.

The observations presented in this paper were performed over 7 nights in 1998 March and June with the 1.5 m Carlos Sanchez Telescope at the Observatorio del Teide (Canary Islands, Spain) (Table 1). We used a CVF photometer with a focal plane chopper, an InSb detector cooled with liquid nitrogen and standard broadband J and K filters. Both the chopping amplitudes and the aperture diameter were 15″. The estimated photometry errors were less than 0.01 mag. The main comparison star was HD 121299. The orbital phases were calculated using the ephemeris given by Koch (1967); namely, Min I (HJD)= 2438107.19047+$0^{\rm d}_{.}81687099$E. The orbital period of BH Vir shows no obvious changes, as was determined by Xiang, Deng and Liu (2000).

Our infrared light curves show equal maxima, especially in the K filter. In order to determine new geometrical elements from the IR light curves, we used the code developed by Budding and Zeilik (1987). This program, based on the Information Limit Optimization Technique (ILOT), is extensively described in Banks (1993) and references therein. The limb darkening coefficients were interpolated from the values given by Claret *et al.* (1995). The mean stellar surface temperatures used to calculate the gravity darkening exponents were $T_1 = 6100$ K and $T_2 = 5800$ K. We attempted to find solutions assuming an initial set of parameter values corresponding to the previously existing determinations. In fact, the radii ratio $k = r_2/r_1$ was varied as an initial parameter from 0.80–1.10. Solutions with a radius ratio in the range 0.91–0.97 fit the observed light curves well, but the smallest χ^2 corresponds to the lower 0.92 value. The inclination angle was always very close to 87°. The infrared light curve solutions are in good agreement with Zeilik *et al.* (1990) determinations from the UBVRI light curves ILOT analysis. In order to stand out these results, in Table 2 we have included Zeilik *et al.* (1990) solutions together with our J and K accepted parameters. The J and K filter models are plotted with the observations in Figure 1.

Table 1: Observing runs

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Observation date	Observed Filters
1–2 March 1998	J, K
2–3 March 1998	J, K
8–9 March 1998	J, K
13–14 March 1998	J, K
14–15 March 1998	J, K
3–4 June 1998	J, K
10–11 June 1998	J, K

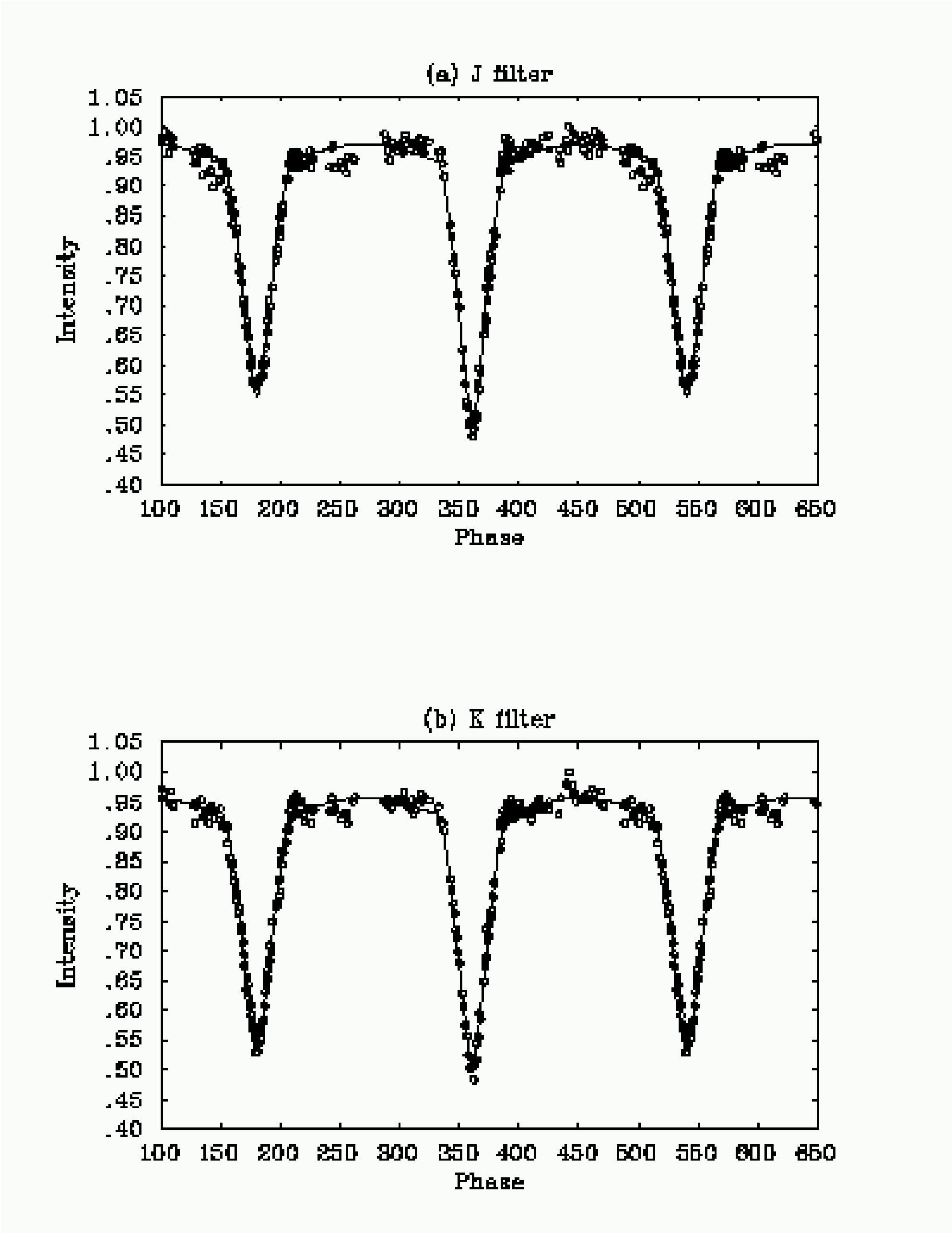

Figure 1. Observed light curves and the fits obtained with *ILOT*. (a) J filter and (b) K filter

Table 2: *ILOT* light curve solutions

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	U filter	B filter	V filter	R filter
L_1	0.649 ± 0.013	0.634 ± 0.008	0.616 ± 0.009	0.600 ± 0.009
L_2	0.307 ± 0.008	0.336 ± 0.004	0.356 ± 0.005	0.374± 0.005
r_1	0.254 ± 0.003	0.255 ± 0.002	0.255 ± 0.003	0.255± 0.003
r_2	0.233 ± 0.003	0.231 ± 0.002	0.233 ± 0.002	0.237± 0.003
k	0.919	0.906	0.914	0.929
i	86°.5± 0.1	86°.5± 0.1	86°.5± 0.1	86°.5± 0.1
χ^2	227	195	257	162
ϵ	0.01	0.01	0.01	0.01
N.Points	199	199	194	198

	I filter	J filter	K filter
L_1	0.586 ± 0.010	0.566 ± 0.008	0.557 ±0.007
L_2	0.386 ± 0.005	0.433 ± 0.002	0.443 ± 0.002
r_1	0.258 ± 0.003	0.255 ± 0.001	0.257± 0.001
r_2	0.241 ± 0.002	0.237 ± 0.001	0.239 ± 0.001
k	0.934	0.929	0.928
i	86°.5± 0.1	86°.7± 0.1	87°.1± 0.1
χ^2	242	520	499
ϵ	0.01	0.01	0.01
N.Points	199	258	256

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