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Light Curve Analysis of the ES UMa Binary

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Abstract. We present a number of multi-night photometric observations of the ES UMa system, carried out from 28/2/07 to 2/6/07 in B,V, R and Ic filters. From these observations, a light curve solution has been acquired.

1. Observations

ES UMa is a relatively new close binary system. Its variability was established by Hanžl, Kyselý and Hornoch in 1993. Only a few complete light curves (Mikulášek & Hanžl 1993) and times of minima (Diethelm 2003; Hübscher et al. 2006; Brát et al. 2008) exist in the literature. The first light elements published by Mikulášek & Hanžl suggest a period of 0.528904 days, a mean B-V index of 0.482 ± 0.004 mag and variability of W UMa type.

The system was monitored from 28/02/07 to 02/06/07 for eight nights with a 30 cm SCT telescope, ST-7 XMEI CCD camera in B, V, R and Ic filters. All images were flat-fielded, while bias and dark frames were subtracted according to standard procedures. We used the calibration and photometry software AIP4WIN V1.25 (Berry and Burnell 2003). The comparison and the check star used were GSC 4383:0698 and 4383:0595 respectively. In total we acquired 279 individual points in B, 784 in V, 296 in R and 610 in Ic filter. Two basic characteristics are apparent in all light curves: a) The W UMa type morphology, and b) the difference between the two maxima (O'Connell effect). Because of the orbital period of more than twelve hours, it was not possible to complete a light curve in a single night. So, it had to be constructed from separate nightly observations. As they also revealed a significant O' Connell effect the observations taken with a time gap of more than a week were incompatible to each other. Therefore, we decided to use only the V band observations from 12/03/07 and 15/03/07, assuming that the spots on the surface of the components would not had the time to evolve significantly. The resulting light curve is presented in figure 1, left panel.

2. Solution

The B-V color index of 0.482 $\pm$ 0.004 mag, reported by Mikulášek & Hanžl (1993) corresponds to an F7 spectral type primary and 6320 $\deg$K. To our knowledge there are no radial velocity curves or other spectroscopic observation available. Therefore, we performed a 'q search' to estimate the value of mass ratio. This procedure yielded q=0.3. For our photometric analysis, we used the PHOEBE program (Prša & Zwitter 2005), which is a software package based on the Wilson-Devinney code (Wilson & Devinney 1971). Keeping only the temperature of the primary T_1 fixed, we performed a number of runs using 0.2, 0.3 and 0.4 as initial values for the mass ratio q. In every case, the later converged to around 0.25. Because of the obvious O' Connell effect, we applied a cool spot on the surface of the secondary to achieve the final fit. The best solution for the system revealed an over contact configuration and it is presented in table 1 and figure 1.

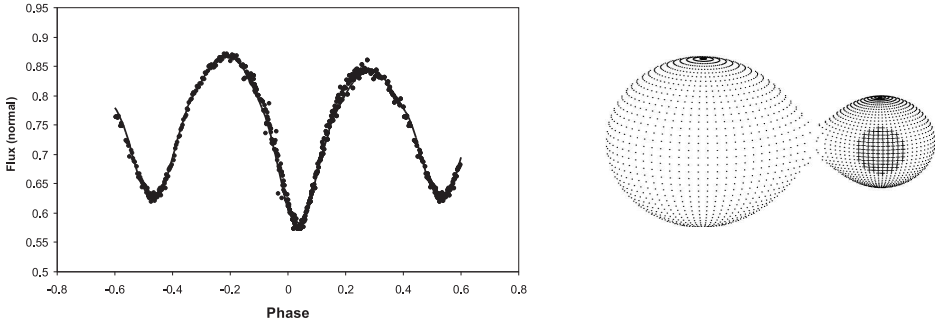

Figure 1.: *Left:* Light curve solution. *Right:* System's configuration.

Table 1.: Spotted solution of ES UMa

System parameter	Value	Spot parameter	Value
q	0.250^a	colatitude (deg)	90^b
$i(deg)$	77.63^a	longitude (deg)	90^b
$T_1(\deg K)$	6320^b	radius (deg)	30^b
$T_2(\deg K)$	5864^a	Temp. ratio	0.8^b
$\Omega_1 = \Omega_2$	2.31124^a		
$g_1 = g_2$	0.25^b		
$A_1 = A_2$	0.5^b		

^{a} adjustable ^{b} fixed

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