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THE UNCONFIRMED ECLIPSING NATURE OF V348 And AND DETECTION OF VARIABILITY OF HD 1438

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Precise photometric observations in standard Johnson-Cousins BVR_c system of a neglected eclipsing binary V348 And were carried out. All the measurements were obtained with the 34-mm refractor at the Private observatory in Brno, using the SBIG ST-7XME CCD camera, and standard B, V and R_c filters by the specification by Bessell (1990). The field of view (FOV) is about $2^\circ \times 3^\circ$, see Fig. 1 left, or equivalently the angular pixel size is circa $14'' \times 14''$. The observations come from the time span from September 2007 to January 2008. The measurements were processed by the software C-Munipack†, which is based on aperture photometry.

V348 And. V348 And (= HD 1082 = HIP 1233, R.A.=$00^h15^m18^s$, Decl.=$+44^\circ12'12''$, J2000.0, V_{max} = 6.76 mag, sp. B9V, according to Simbad database) is one member of an astrometric binary A 1256 (the second component is less then $1''$ distant). The observations obtained by the Hipparcos satellite (see Peryman & ESA, 1997) indicate that the system is an Algol-type eclipsing binary with its orbital period 5.5392 days (Kruszewski & Semeniuk, 1999).

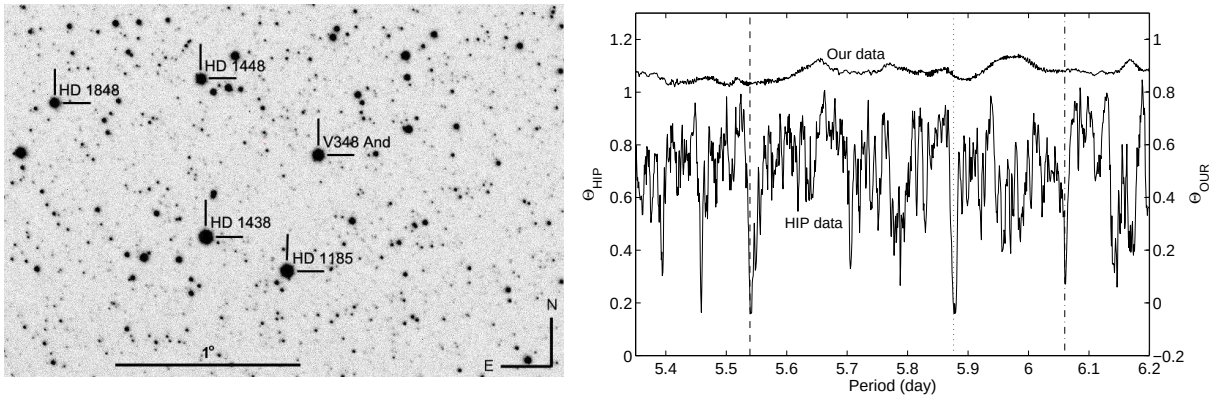

Figure 1. Left: Identification frame for the stars. Right: PDM spectrum for Hipparcos and our data. Also the different periods are plotted, the dashed one for 5.5392 days, the dash-dotted one for 6.06 days, and the dotted one for 5.876 days.

Since its discovery as an eclipsing binary, the photometric variation has not been confirmed so far. The Hipparcos observations of the two eclipses were the only ones, which were used for estimation of its light elements. Regrettably, two minima observed

† See http://integral.sci.muni.cz/cmunipack/

by the Hipparcos satellite were not covered by the data sufficiently, and only 8 points were used for estimation of these minima and its orbital period. According to a light curve observed by Hipparcos, a predicted depth of the primary minimum of the star should be at least 0.13 mag and its duration, D more than 10 hours.

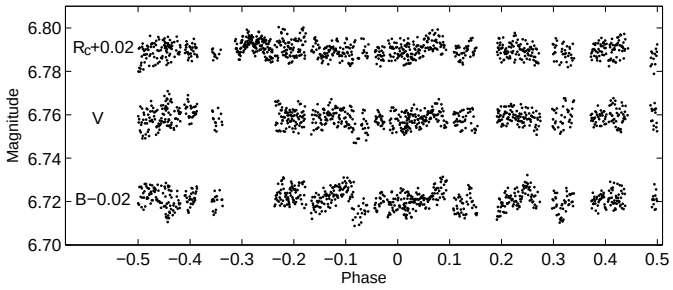

Figure 2. The B, V and R_c light curves of V348 And. The shift ± 0.02 mag was applied to R_c and B observations for the better clarity of the plot.

Since September 2007, we have tried to reproduce the observations made by Hipparcos and using B, V and R_c filters, the star has been observed each clear night, until a phase light curve of the system was covered. The data files are available through the IBVS website as `5827-t1 – 5827-t3.txt`. HD 1185 (= HIP 1302, R.A.=$00^{\rm h}16^{\rm m}22^{\rm s}$, Decl.=$+43°35'42''$, J2000.0, $V = 6.15$ mag, sp. A2V, according to Simbad database) was used as a comparison star. As check stars to control the non-variability of this star we used the two following stars HD 1448 and HD 1848 (see Fig. 1 left). No visible variabilities between these three stars were observed. The final result is presented in Fig. 2, where the phase light curves in B, V and R_c filters are plotted (the period 5.5392 days was used). We assumed that the minimum is detectable in all filters, and the light curve is well covered at least in R_c filter. Despite the scatter in each filter is circa 0.01 mag, there has not been detected any observable photometric decrease. No minimum occurred during these 19 nights of observations (more than 100 hours of observations in total). The PDM spectrum of our observations as well as of Hipparcos data are plotted in Fig. 1 right. The result is that the orbital period of the system is different than presumed on the basis of the Hipparcos data. Using the Hipparcos photometry, the period could be also a different one, about 5.876 or 6.06 days (see the different minima in the PDM spectrum in Fig. 1 right and also the Hipparcos light curves in Fig. 3). According to our new observations only, one is not able to judge whether the orbital period is one of the suggested periods above or other one, further photometric observations are still needed.

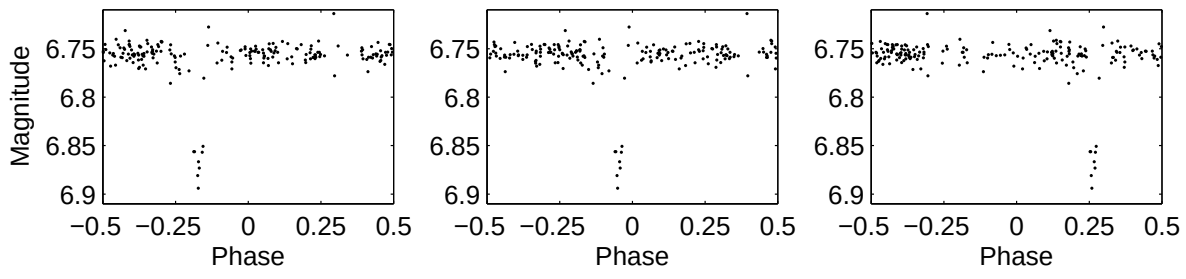

Figure 3. The light curves of V348 And according to the Hipparcos data, the periods 5.5392, 5.876, and 6.06 days were used, respectively (from left to right).

HD 1438. Another interesting result from the observing campaign of V348 And was the discovery of a photometric variability of the star HD 1438 (= 26 And A = HR 70 = HIP 1501, R.A.=$00^h18^m42^s$, Decl.=$+43°47'28''$, J2000.0, V = 6.11 mag, sp. B8V, according to Simbad database). This star is about 30 arc minutes distant from V348 And.

The star is a primary component of an astrometric binary ADS 254, while the secondary (NSV 119) is about 4 magnitudes fainter and circa $6''.2$ distant. No changes in position angles of the two components have been detected yet, so its possible orbital period is more than a thousand years. Baize (1962) mentioned a possible long-term photometric variation of the secondary component. This variation is very slow (9.5 mag in 1845, 11.0 mag in 1913, 12.0 mag in 1934, 11.2 mag in 1959) and has not been explained so far. The spectral types were estimated as B8V+F3V (according to Lindroos, 1985 and Wyatt, 2003), while Soderblom et al. (1991) presented the spectral types B8V+dG0. Wyatt (2003) also derived a distance of the system about 212 pc, and investigated a possible presence of a dust disc around the star. The submillimeter observations of the star indicate presence of the disc with the temperature about 100 K with its total mass about 0.05 $M_\oplus$.

Our new photometric observations of the star from the same time epoch as V348 And indicate a shallow photometric variability (see Fig. 4). Such a variability has an amplitude about only 0.015 mag, but despite this fact, it is clearly visible in all B, V and R_c filters. Its period is about 1.6 days.

The nature of these variations could be explained by presence of a pulsating component in the system. Due to the small telescope used (because of the high brightness of the stars), the components A and B could not be resolved into separate stars and one is not able to judge, whether the variable component is the primary, or the secondary one.

There could be also an alternative explanation of the variability. Almost sinusoidal oscillations could be also described as ellipsoidal variations (close binary with tidally distorted stars, where the components are not eclipsing each other). This solution was presented in Fig. 4 with the theoretical fit, while the parameters of such fit are in Table 1. The final period of such variation is therefore doubled, about 3.16 days.

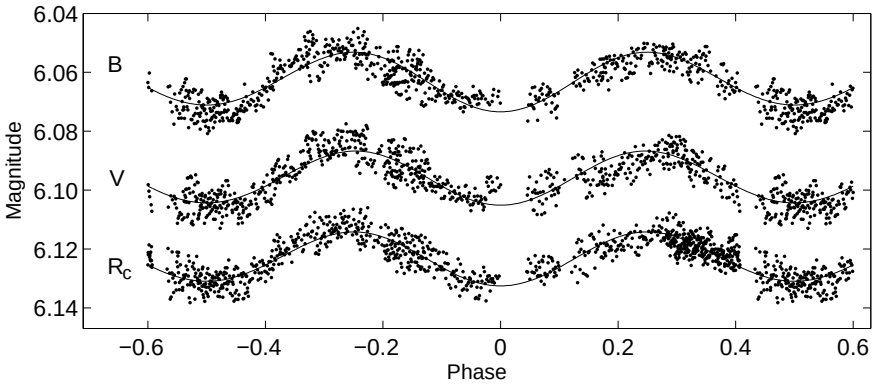

Figure 4. The B, V and R_c light curves of HD 1438.

Altogether there are 806 (B), 855 (V) and 1040 (R_c) observations, respectively. The data files are available through the IBVS website as `5827-t5 – 5827-t7.txt`. For analysis the PHOEBE programme (see e.g. Prša & Zwitter, 2005), based on the Wilson-Devinney algorithm (Wilson & Devinney, 1971), was used. The value of the mass ratio was estimated via the "q-search" method, see Fig. 5 for the sums of squares in the individual passbands as a function of the mass ratio. This value results in $q = 0.7 \pm 0.2$. The temperature of the primary was fixed at the typical value for B8V stars (11600 K, see

Harmanec, 1988). The amount of the third light was also computed, but its contribution to the total light is only very small (below 1 percent) and such a low value is comparable with its respective error. The value of the third light reveals that the variable is the primary component. Nevertheless, further observations are still needed, especially the spectroscopic ones to confirm the nature of this system.

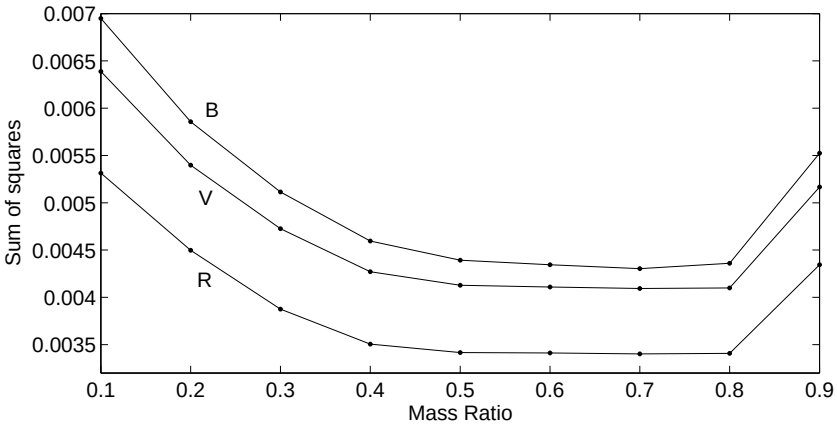

Figure 5. Sum of squares as a function of the mass ratio.

Table 1. The physical parameters of HD 1438.*

Parameter	Value	Parameter	Value
HJD_0	2454360.21 ± 0.05	T_1/T_2	> 2.68
P [day]	3.163063 ± 0.000002	r_1/r_2	0.77
i [deg]	38.8 ± 3.9	Ω_{crit}^{L1}	3.24
L_1/L_2 (B)	63 ± 3	Ω_{crit}^{L2}	2.84
L_1/L_2 (V)	343 ± 32	Ω_1	4.18 ± 0.16
L_1/L_2 (R_c)	188 ± 14	Ω_2	3.11 ± 0.24

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