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TYC 4031-791-1 - A NEW ECLIPSING BINARY OF ALGOL TYPE

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TYC 4031-791-1 is an 11th magnitude star located in the constellation Cassiopeia in close proximity (8.2 arcmin) to the long-period eclipsing binary AZ Cas ($P_{\text{orb}} \approx 9.3$ yr). We have monitored the photometric variability of AZ Cas since August 2003 with the 60-cm Cassegrain telescope at Piwnice Observatory (53.0943°N, 18.5532°E). In 2005 we switched from photomultiplier to CCD (SBIG-STL-1001) and we needed new comparison stars for photometry. TYC 4031-791-1 was one among many in the group of stars that have been tested to establish the sequence of comparison stars for AZ Cas (Galan et al. 2012), suitable for the narrow field of view of our CCD camera (11.4' × 11.4'). We collected differential light curves for TYC 4031-791-1 with respect to all comparison stars during the last 7 years. We have observed deviations with similar amplitudes in all ($UBV(RI)_C$) photometric bands (the V light curve is shown in Fig. 1).

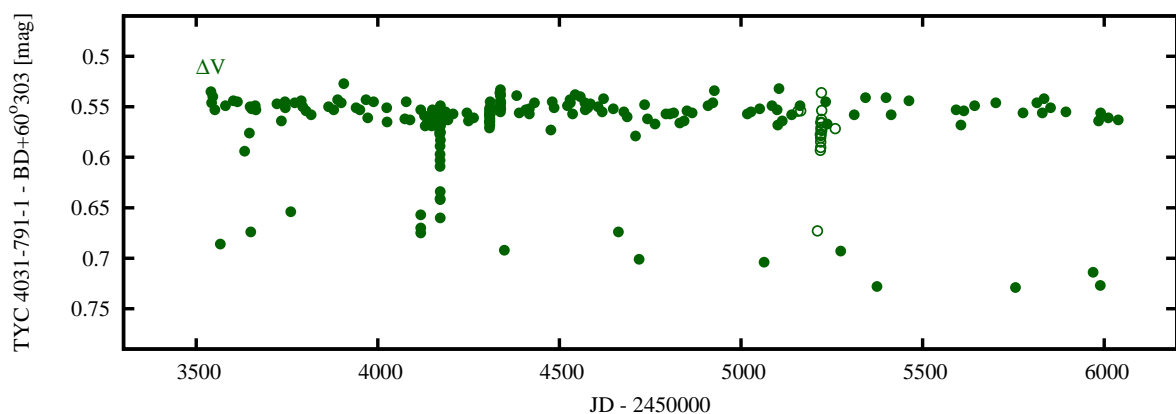


Figure 1. The V band differential light curve of TYC 4031-791-1 obtained with respect to BD+60°303. The data collected at Piwnice Observatory are shown with filled circles. Some of the data, presented with open circles, have been obtained with the 25/250 cm Schmidt-Cassegrain telescope and a SBIG-ST-8XME CCD camera at the Olsztyn Planetarium and Astronomical Observatory.

We checked that this star has not been reported variable in the GCVS catalogue (Samus et al. 2012) or in any other electronically available database. Assuming that the observed phenomenon is caused by eclipses, we searched for the orbital period using the PerSea 2.6 tool (a program written by Gracjan Maciejewski: <http://www.astr.uni.torun.pl/~gm/software.html>), in which the ANOVA method for optimal period search by Schwarzenberg-Czerny (1996) is implemented. We have obtained the orbital period of 6.6827 ± 0.0002 days. Using the method of Kwee & van Woerden (1956) we have determined the time of primary minimum and obtained the ephemeris:

$$JD_{\text{mid-ecl}} = 2453650.327(\pm 0.015) + 6.6827(\pm 0.0002) \times E \quad (1)$$

The BVR_C light curves phased with the orbital period are shown in Figure 2. The secondary minimum occurs at phase 0.445 ± 0.003 indicating that the orbit is slightly eccentric. The minima are quite shallow - the primary minimum is not deeper than $0^m.2$. The second eclipse is shallower by about only $0^m.02$. The depths of the eclipses seem to be independent or depend very weakly on the photometric band. This suggests that the photospheres of the system components may have similar effective temperatures.

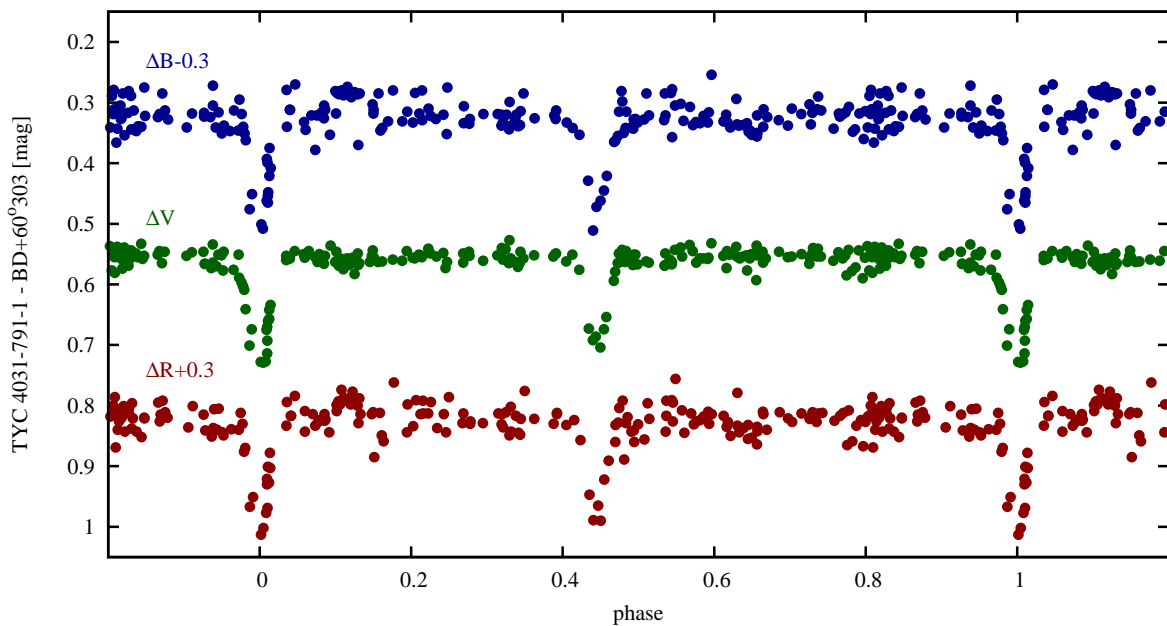


Figure 2. BVR_C light curves of TYC 4031-791-1 phased with the orbital period.

Fransworth (1956) has reported B1 spectral type for TYC 4031-791-1. In the spectrum obtained on Mar 10, 2003 (Fig. 3), the strongest features are the $H\alpha$, $\text{HeI } 5876\text{\AA}$ and $\text{HeI } 6677\text{\AA}$ absorption lines which confirms that star is of type B. However, the position of TYC 4031-791-1 on the $U - B$, $B - V$ two-color diagram (Fig. 4) indicates a somewhat later spectral type: B5 with an accuracy of about 3 subtypes. TYC 4031-791-1 is strongly reddened by interstellar matter – the color excess is large: $E(B - V) = 0.72 \pm 0.12$. This explains the very strong DIBs (5780\AA , 5797\AA , 6284\AA , 6614\AA) and NaI interstellar doublet in the spectrum (Fig. 3).

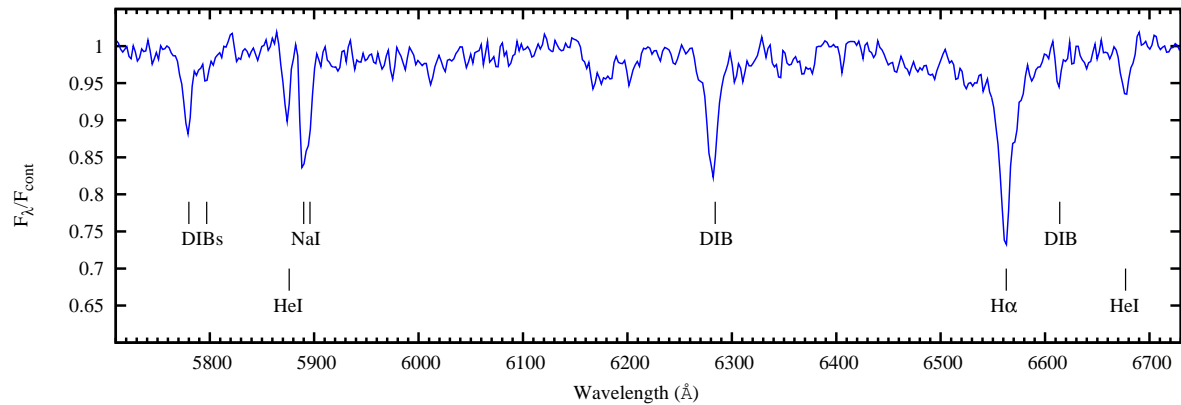


Figure 3. A medium resolution spectrum ($R \sim 2000$) of TYC 4031-791-1, obtained on Mar 10, 2007 with the CCS spectrograph on the 60/90-cm Schmidt-Cassegrain telescope at Piwnice Observatory.

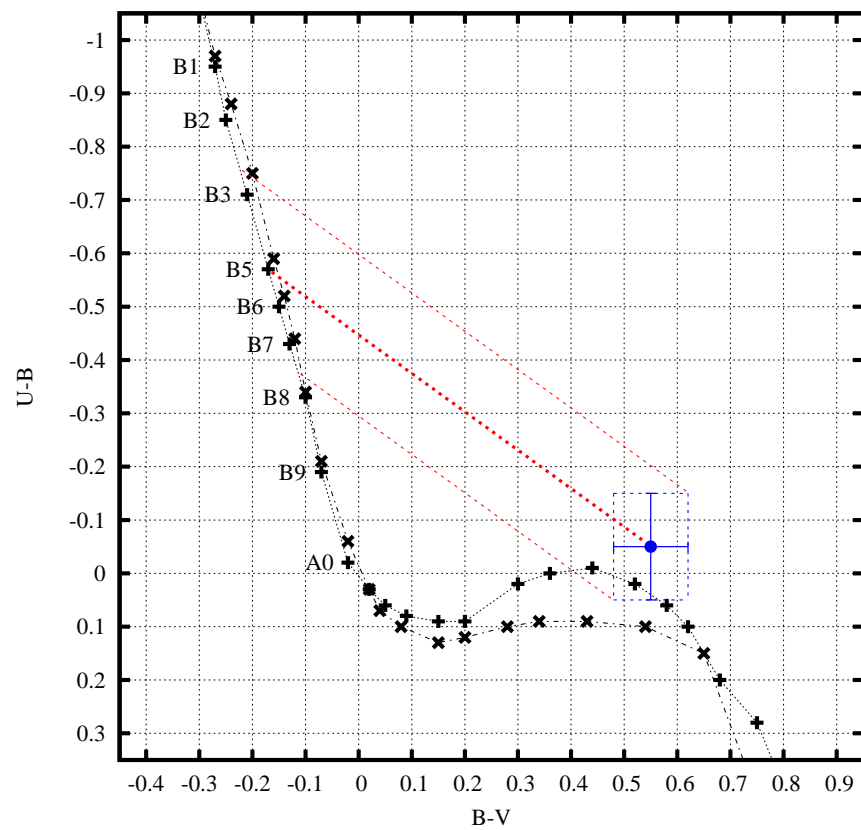


Figure 4. Location of TYC 4031-791-1 on the $U - B$, $B - V$ color-color diagram (blue point with errorbars), constructed with average out-of-eclipse magnitudes of the star: $m_U = 11.66 \pm 0.06$, $m_B = 11.71 \pm 0.04$, $m_V = 11.16 \pm 0.03$ (Galan et al. 2012). The calibrations of Straižys (1977) for dwarfs (+) and giants (x) are shown as well. The red-dashed lines indicate the direction of the interstellar reddening.

Additional photometric and spectroscopic observations are needed to constrain the system parameters further. We intend to obtain accurate multicolor photometry of eclipses using our ephemeris and radial velocities with high-resolution spectra for further analysis.

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