DE CVn: A bright, eclipsing red dwarf – white dwarf binary

E.J.M. van den Besselaar[1], R. Greimel[2], L. Morales-Rueda[1].G. Nelemans[1], J.R. Thorstensen[3], T.R. Marsh[4], V.S. Dhillon[5], R.M. Robb[6], D.D. Balam[6] E.W. Guenther[7], J. Kemp[8], T. Augusteijn[9], and P.J. Groot[1]

besselaar@astro.ru.nl | http://www.astro.ru.nl

1. Introduction

DE CVn is a detached white dwarf - red dwarf (WD+RD) binary with a relatively short (∼8.7 hours) orbital period. All close WD+RD binaries must have gone through a common-envelope (CE) phase during their evolution. DE CVn's brightness and the presence of eclipses makes this system ideal for a more detailed study. Our aim is to derive its system parameters from a study of photometric and spectroscopic observations and ultimately to set limits on the physics of the CE phase.

2. Observations

We obtained photometry and spectroscopy of DE CVn on a number of telescopes and epochs. Simultaneous photometry was obtained in u', g' and i' bands with ULTRACAM on the WHT. Additional photometry was obtained in the B, R, V, $BG38$ and clear filters. The main spectroscopic observations are echelle observations with the 2m telescope in Tautenburg and long-slit spectroscopy with the MDM and WHT telescopes.

3. Photometry

By combining the photometry available and the published times of mid-eclipse from Robb & Greimel (1997) and Tas et al. (2004), we obtain a new, more accurate ephemeris:

$$HJD_{\rm min} = 2452784.55337(2) + 0.36413945(4) \times E$$

with the uncertainty on the last digits in parentheses. Figure 1 shows the ULTRACAM photometry of the eclipse of DE CVn on the night of May 24th in 2003.

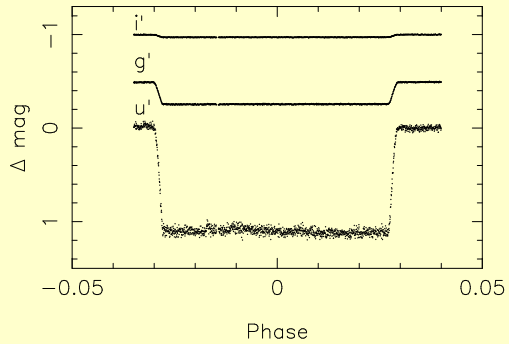

Fig. 1: Primary eclipse simultaneously observed with ULTRACAM in the u', g' and i' filters.

4. Spectroscopy

We have used the low-resolution spectra to derive the composition of DE CVn. The WD atmospheres were kindly provided by P. Bergeron (with 1500 K < T < 17000 K). RD templates (M0V - M6V) have been obtained from Pickles (1998). Single templates are first scaled to 10 pc, then added and fitted to the observed spectrum, including a distance offset. The combination with lowest χ^2 is taken as the best fit and is shown in Fig. 2. From the echelle spectroscopy we derive the semi-amplitude of the radial velocity curve of the RD.

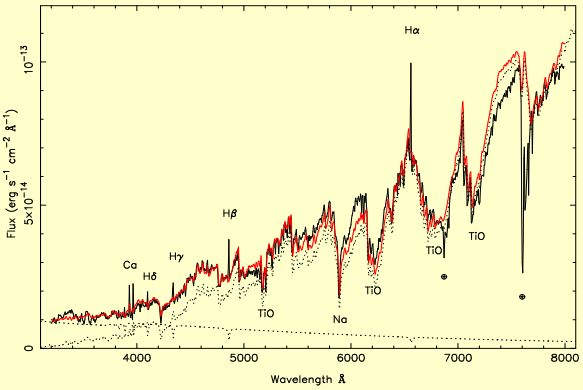

Fig. 2: A combined low-resolution spectrum together with a composite spectrum of an M3V star and a DA white dwarf (see Table 1 for details, red line). The single components are shown in thin dotted lines.

Table 1: Derived parameters for the binary DE CVn.

Parameter	Value
WD temperature	8000 ± 2000 K
WD $\log g$	7.5
RD spectral type	M3V
WD mass	$0.54 \pm 0.04 M_\odot$
WD radius	$0.0132 \pm 0.0006 R_\odot$
RD mass	$0.40 \pm 0.05 M_\odot$
RD radius	$0.40 \pm 0.04 R_\odot$
Orbital separation	$2.10 \pm 0.06 R_\odot$
Semi-amplitude	166 ± 4 km s^{-1}
Inclination	$\geq 82^\circ$
Distance	26 ± 3 pc

5. Conclusion

The results of our photometric and spectroscopic analysis are listed in Table 1. DE CVn is an eclipsing binary consisting of a cool WD and an M3 star that must have experienced a CE phase. From evolutionary tracks we derive a WD progenitor mass of M $\leq 2M_\odot$. The time remaining before the system becomes semi-detached is 1.7×10^{10} years. This kind of systems will not contribute to the current sample of Cataclysmic Variables, unless the loss of angular momentum in the current detached phase is much higher than that given by magnetic braking alone.

[1]Radboud University Nijmegen, The Netherlands, [2]ING, La Palma, [3]Dartmouth College, USA, [4]Warwick, UK, [5]Sheffield, UK, [6]Victoria, Canada, [7]Tautenburg, Germany, [8]Joint Astronomy Centre, Hawaii, [9]NOT, La Palma

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