Structure of accretion flows in the nova-like Cataclysmic variable RW Tri

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Abstract.We obtained photometric observations of the nova-like (NL)cataclysmic variable RW Tri and gathered all available AAVSO and other datafrom the literature. We determined the system parameters and found theiruncertainties using the code developed by us to model the light curves of binarysystems. New time-resolved optical spectroscopic observations of RW Tri werealso obtained to study the properties of emission features produced by the system.The usual interpretation of the single-peaked emission lines in NL systems isrelated to the bi-conical wind from the accretion disc's inner part. However, wefound that the Hα emission profile is comprised of two components with differentwidths. We argue that the narrow component originates from the irradiated surfaceof the secondary, while the broader component's source is an extended, low-velocity region in the outskirts ofthe accretion disc, located opposite to thecollision point of the accretion stream and the disc. It appears to be a commonfeature for long-period NL systems – a point we discuss.

Keywords binaries: spectroscopic – stars: individual: RW Tri – novae,cataclysmic variables.

I. Introduction

RW Tri was discovered as an eclipsing binary system by Protitch [1]. GAIA distance of the system is 315.5±5.0 pc [2]. It is in a good agreement with previous HST parallax measurements 341(−31+38) pc [3]. The first extensive photoelectric photometry in the UBV system was reported by [4]. He showed that the object besides eclipses varies inbrightness at a long and short time-scale. The depth of eclipse depends on the brightness of the system, which itself does not presentany periodicity either on long or short scales. The orbital period ofthe system is P(orb) =0.23188324±4×10−8 days [5]. The light curve of RW Tri has a close similarity to UXUMa, a prototype of NLs. [6] observed RW Triat the near-infrared (nIR) JHK bands. The objectwas in a dim state at B≈13.3 mag.

II.Observations

PHOTOMETRY

A time-resolved CCD photometry of RW Tri has been obtained at the Ondřejov Observatory, Czech Republic, since 2012. The Mayer 0.65 m (f/3.6) reflecting telescope with the CCD camera G2-3200 and VR photometric filters were used. Aphot, synthetic aperture photometry, and astrometry software were used for data reduction. Time-resolved V-band CCD photometric data were obtained on 2016 September 8-11, and on 2016 November 14,16, and 17 using

0.84m telescope and MEXMAN filter-wheel of Observatorio Astronomico Nacional at San Pedro Mártir (OAN-SPM), Mexico.

SPECTROSCOPY

The spectroscopic data of RW Tri were obtained using the echelle REOSC [7] and Boller & Chivens long-slit spectrograph attached to the 2.1-m telescope of the OAN-SPM. The echelle spectrograph provides spectra spread over 27 orders, covering the spectral range 3500-7100 Å with the spectral resolving power of R=18000. A total of 79 echelle spectra were obtained in 2016, September, and October. The echelle spectroscopy was obtained simultaneously with time-resolved photometric observations.

III. Experiment and Result

Photometry and the light curvemodelling of RW TRI

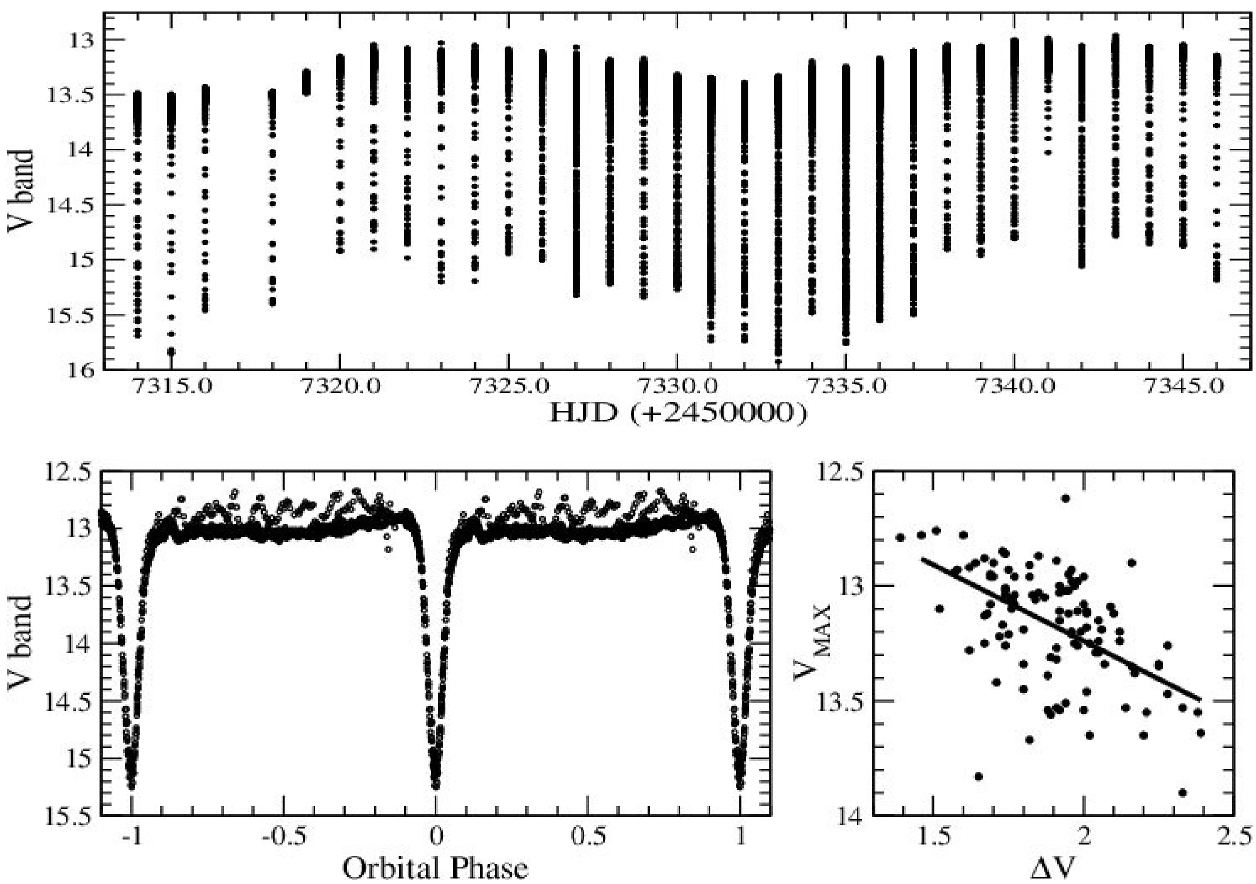

Fig 1. Top panel: Long-term light curve of RW Tri collected by AAVSO. Bottom-left: The example of the V band light curve of RW Tri folded on the orbital period. The data were obtained in four consecutive nights in OAN-SPM. The light curve with flickering is shown by the open circles and the oppositeis presented by the filled circles. The difference in out-eclipse behaviors for diverse orbital cycles is clearly visible. Bottom-right: The relationship between out-eclipse maximal brightness and the depth of the eclipse.

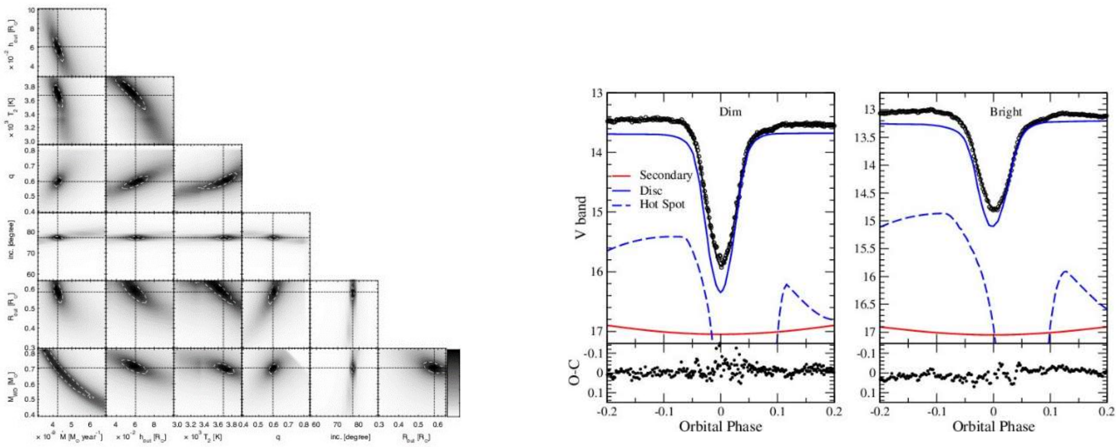

Fig 2. Right-top panels: Examples of eclipses (open circles) in the‘bright’ (right) and in the ‘dim’ (left) state of the system and results of the light curve modeling (solid line). Contribution of different system components in the total flux are marked. The corresponding O−C (observed minus calculated) diagrams are given in the bottom panels of this plot. Left gray scale panels: Errors of the fit for the light curve in the ‘dim’ state. The black dashed lines mark the best fit values of parameters. The white long-dashed lines corresponds 1σ errors of parameters.

Spectroscopy and doppler tomography

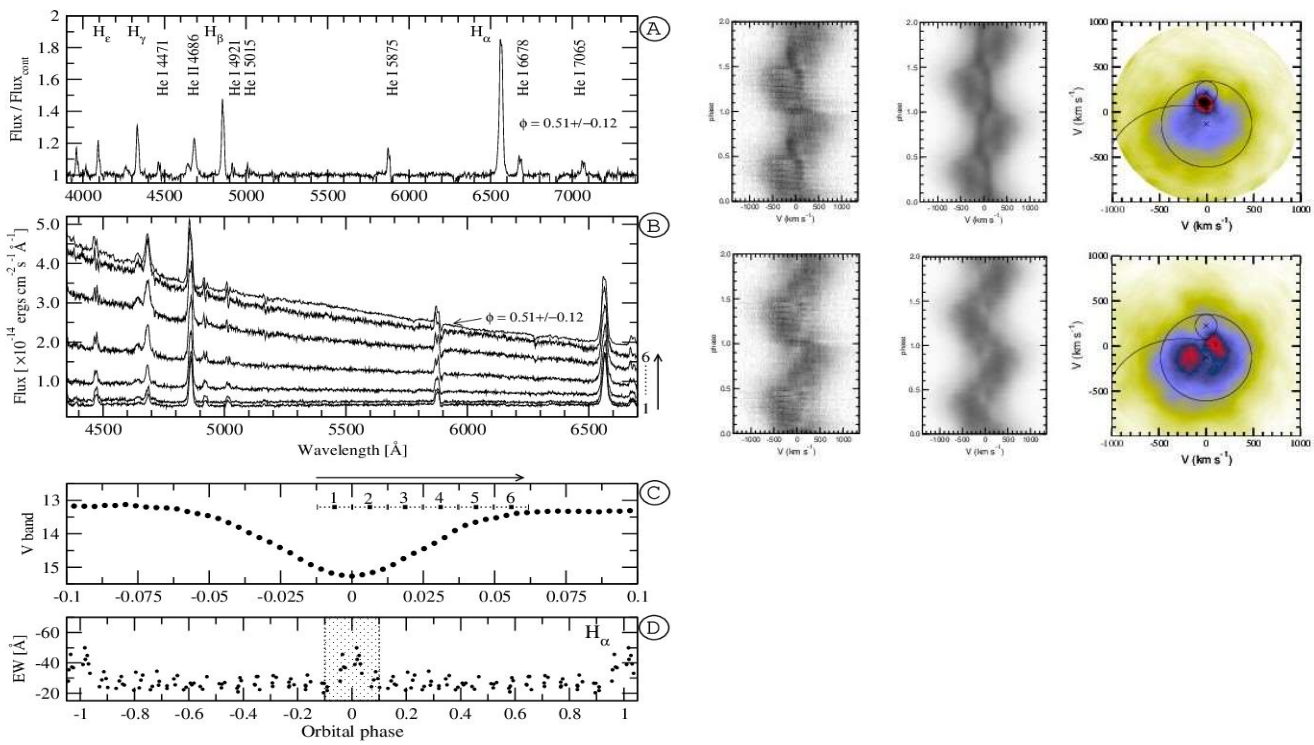

Fig 3. A: Normalized low-resolution spectrum of RW Tri averaged over a stretch of φ=0.47−0.73 orbital phases. B: Spectral evolution of RW Tri from the bottom to clearing of the eclipse. The final (top) spectrum corresponds to the average spectrum for φ=0.47−0.73 orbital phases. C: The eclipsing light curve of RW Tri in the V-band obtained close to the spectral observations. The filled squares mark the orbital phases when the spectra were acquired. D: The behaviour of equivalent widths (EW) of the Hαemission line during the orbital period. The selected region corresponds to the panel C abscissa range.**On the right panel:** Top panels from left to right: The observed, reconstructed trailed spectra around Hαemission line and corresponding Doppler tomogram. Bottom:The observed, reconstructed, and Doppler tomogram after removing the narrow component of the emission line. The Keplerian

velocity of the disc in theDoppler maps is located atυdiscsin(i) ≥470 km s−1and the circle shows the disc external radius. The system parameters discussed in the text.

IV.CONCLUSION

New time-resolved optical spectroscopic observations of RW Triwere also obtained to study the properties of emission features produced by the system. Theusual interpretation of the single-peaked emission lines in nova-like systems is related tothe bi-conical wind from the accretion disc's inner part. However, we found that the Hαemission profile is comprised of two components with different widths. We argue that thenarrow component originates from the irradiated surface ofthe secondary, while the broadercomponent's source is an extended, low-velocity region in the outskirts of the accretion disc,located opposite to the collision point of the accretion stream and the disc. It appears to be acommon feature for long-period nova-like systems – a point we discuss.

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