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Spectroscopic follow-up of the colliding-wind binary WR 140 during the 2009 January periastron passage

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Abstract. We present the results from the spectroscopic follow-up of WR140 (WC7 + O4-5) during its last periastron passage in january 2009. This object is known as the archetype of colliding wind binaries and has a relatively large period ($\simeq$8 years) and eccentricity ($\simeq$0.89). We provide updated values for the orbital parameters, new estimates for the WR and O star masses and new constraints on the mass-loss rates.

Keywords. binaries: general, stars: fundamental parameters, stars: Wolf-Rayet, stars: winds, outflows

1. Introduction

WR140 is a very eccentric WC7+O5 colliding-wind binary (CWB) system with an eccentricity of 0.89 and a long period of 7.94 years. It is also the brightest Wolf-Rayet star in the northern hemisphere and is considered as the archetype of CWB. We present here the results from a spectroscopic follow-up, unique in time coverage and resolution. The observation campaign was a worldwide collaboration involving professional and amateur astronomers and took place during a period of 4 months around periastron passage in January 2009.

2. Radial velocities

The WR star radial velocities were measured by cross correlation with a reference spectrum and the O star radial velocities by measuring the centroid of the photospheric absorption lines (see Fig. 1). We notably find a higher eccentricity than previously

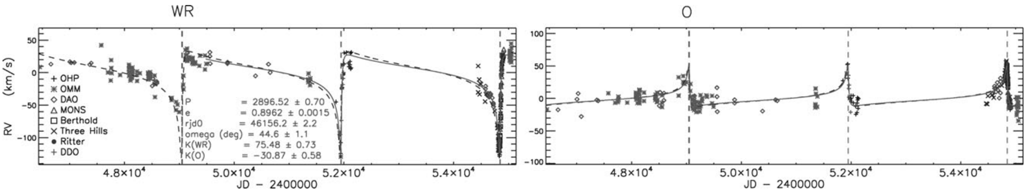

Figure 1. Measured radial velocities of the WR star and of the O star together with the fit for the orbital solution (full line). We included data from the last periastron campaign in 2001 (M03). The black dashed line is the orbital solution from M03. The dashed vertical lines show the position of the periastron passage. The best fit parameters are indicated in grey.

published (e = 0.896 ± 0.002 cf. 0.881 ± 0.005 from Marchenko *et al.* (2003) = M03) and an updated value for the period (2896.5 ± 0.7 d instead of 2899.0 ± 1.3 d).

3. Excess emission

The presence of a shock cone around the O star induces an excess emission that we measured on the CIII 5696 flat top line. This excess emission appears first, just before periastron passage, on the blue side of the line, and then moves quickly to the red side, just after periastron passage, before it disappears. We fitted the radial velocity and the width of this excess as a function of orbital phase using a simple geometric model (Luehrs 1997). We find a value for the inclination of 52±8° (cf. 58±5° from Dougherty *et al.* 2005) which gives the following estimation for the stellar masses : M_{WR} = 18.4±1.8 $M_\odot$ and M_O = 45.1±4.4 $M_\odot$ (cf. 19 $M_\odot$ and 50 $M_\odot$ from M03). From the half opening angle of the shock cone (Canto *et al.* 1996), we also find a wind momentum ratio $\eta = 0.028 \pm 0.009$.

4. Conclusion

The 2009 periastron campaign on WR140 provided updated values for the orbital parameters, new estimates for the WR and O star masses and new constraints on the mass-loss rates. However, our capability to measure the shock cone parameters with confidence and to understand its underlying physics is limited by the over simplistic approach of our model. A more sophisticated theoretical investigation should be done. Meanwhile, the measured d^{-2} dependency of the excess (where d is the orbital separation) strongly suggests that some kind of isothermal process is involved here. Links with observations in other spectral domains (X,IR and radio) will certainly provide valuable clues about the physics. Finally, we will attempt to isolate the WR spectrum from the O-star spectrum from our data in order to identify the spectral type of the latter more precisely.

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