WR 148 and the not so compact companion

Melissa Munoz¹, Anthony J. Moffat¹, Grant M. Hill², Tomer Shenar³, Noel D. Richardson⁴, Herbert Pablo¹, Nicole St-Louis¹ and Tahina Ramiaramanantsoa¹

¹Université de Montréal, ²W. M. Keck Observatory, ³Institut für Physik und Astronomie, ⁴University of Toledo

Abstract. The objective is to determine the nature of the unseen companion of the single-lined spectroscopic binary, WR 148 (= WN7h+?). The absence of companion lines supports a compact companion (cc) scenario. The lack of hard X-rays favours a non-compact companion scenario. Is WR 148 a commonplace WR+OB binary or a rare WR+cc binary?

Keywords. binaries: spectroscopic, stars: Wolf-Rayet, stars: individual (WR 148).

WR 148 (WN7h) is a single-lined spectroscopic binary with an established period of 4.3174 d suspected to harbour either a low mass B star or a black hole companion (Marchenko et al. 1996). We obtained two nights of spectra from the Keck Observatory at both quadratures complemented by additional other spectra from l’Observatoire du Mont-Mégantic (OMM) in the summers of 2014 and 2015.

The high resolution and high signal-to-noise ratio Keck spectra reveal absorption lines moving in anti-phase to the WR emission lines with similar velocity amplitude (see Table 1 for the orbital elements). Considering an orbital inclination of ~ 67°, derived from previous polarimetry observations (Drissen et al. 1986), the system’s total mass would be a mere 2-3 M⊙; an unprecedented result for suspected massive binary.

<table>
<thead>
<tr>
<th>Object</th>
<th>P [days]</th>
<th>E [HJD - 2,440,000]</th>
<th>γ [km s⁻¹]</th>
<th>K [km s⁻¹]</th>
</tr>
</thead>
<tbody>
<tr>
<td>WR star</td>
<td>4.317336 ± 0.000026</td>
<td>4825.04 ± 0.03</td>
<td>88.1 ± 3.8</td>
<td>-131.4 ± 2.7</td>
</tr>
<tr>
<td>Companion</td>
<td></td>
<td></td>
<td>79.2 ± 3.1</td>
<td>-120.1 ± 1.2</td>
</tr>
</tbody>
</table>

We apply the shift-and-add technique to disentangle the spectra and obtain a companion spectrum compatible with an O5 spectral type. Assuming a typical mass for an O5 V type from Martins et al. 2003, we obtain a new orbital inclination of ~ 20°. This discrepancy in inclination angle can be reconciled with a revised error assessment on the polarisation data. In fact, Wolinski & Dolan (1994) demonstrate that polarimetrically-derived inclination angles have a statistical bias towards higher angles.

To summarise, WR 148 is found to be a normal, massive, close WN7+O5 binary system. Though not discussed here, evidence of colliding winds has been discovered as well as thermal X-rays compatible with other WR+O colliding wind binaries.

References