Characterizing the properties of the VFTS 176 binary in the 30 Dor. starburst region

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Abstract

In this work we present an analysis of the massive binary system VFTS 176. Located in the 30 Doradus starburst region in the LMC, VFTS 176 is a close binary system with an orbital period of 1.77 days. The small orbital separation of this system (a âˆ¼ 0.1 AU) raises the question if the two stars may have had a past phase of mass-transfer. To address this question, we map all key stellar properties of both stars. For our analysis we use 32 observational epochs from the TMBM survey, which itself is a subset from the larger VLT-FLAMES program targeting the 30 Doradus region. We use a spectral disentangling technique (FDbinary) to separate the contribution of the primary and secondary component, as well as that of nebular contamination from nearby gas. FDbinary uses Fourier
techniques to retrieve the radial velocity of both components in each epoch, which allows to reconstruct part of the orbital properties. After disentangling, we use quantitative spectroscopy to extract the stellar parameters of both components from their respective spectrum. We find for the primary T_eff = 39450 (+300 âˆ’450) K, log(g)= 3.99 (+0.04 âˆ’0.06) dex and M_spec = 28.83 (+2.83 âˆ’3.40) solar masses. For the secondary we find T eff = 28800 (+2200 âˆ’1650) K, log(g)= 4.3 (+0.2 âˆ’0.17) dex and M_spec = 13.57 (+6.53 -3.92) solar masses. Assuming the stars have not yet interacted, we use BONNSAI to fit stellar evolution models. We find a stellar age of 2.54 (+0.21 âˆ’0.15) Myr and 2.48 (+4.01 âˆ’2.48) Myr for the primary and secondary respectively as well as their predicted initial mass and rotation at the ZAMS. We conclude that they are both main sequence stars that are relatively young. We performed a statistical t-test to rule out that the posterior age distributions of both stars are uncorrelated, and find a p-value of âˆ¼ 1.1 Â· 10^(âˆ’9) . Furthermore, the system does not appear tidally synchronized. There is thus no hint for a past phase of mass-transfer, where one star rejuvenated its companion. However, we predict the stars will interact around 4.20 Myr. At that age, we predict the primary has filled its Roche
Lobe and starts to transfer mass to its companion while still on the main sequence. This interaction will drastically change the path of the components towards their final stage.