The VLT-FLAMES Tarantula Survey. XIV: On the nature of O,V z stars in 30 Doradus

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Context. OV z stars, a subclass of O-type dwarfs characterized by having HeII4686 stronger in absorption than any other helium line in their blue-violet spectra, have been suggested o be on or near the Zero-Age-Main-Sequence (ZAMS). If their youth were confirmed, they would be key objects with which to advance our knowledge of the physical properties of massive stars in the early stages of their lives.

Aims. To test the hypothesis of OV z stars being at a different (younger) evolutionary stage in comparison with normal O-type dwarfs.

Methods. We perform the first comprehensive quantitative spectroscopic analysis of a statistically-meaningful sample of OV z and OV stars in the same star-forming region, exploiting the large number of OV z stars identified by the VLT-FLAMES Tarantula Survey in the 30 Doradus region of the Large Magellanic Cloud (LMC). We obtain the stellar and wind parameters of 38 OV z stars (and a control sample of 46 OV stars) using the FASTWIND stellar atmosphere code and the IACOB-GBAT, a grid-based tool developed for automated quantitative analysis of optical spectra of O stars. In the frame of a differential study, we compare the physical and evolutionary properties of both samples, locating the stars in the logg vs. logT_eff, logQ vs. logT_eff, and logL/L_sun vs. logT_eff diagrams. We also investigate the predictions of the FASTWIND code regarding the O,V z phenomenon.

Results. We find a differential distribution of objects in terms of effective temperature, with OV z stars dominant at intermediate values. The OV z stars in 30,Doradus tend to be younger (i.e. closer to the ZAMS), less luminous, and have weaker winds than the OV stars, but we also find examples with ages of 2-4 Myr, and with luminosities and winds which are similar to those of normal O dwarfs. Moreover, the OV z stars do not appear to have higher gravities than the OV stars.
In addition to effective temperature and wind strength, our FASTWIND predictions indicate the importance of taking other stellar parameters (gravity and projected rotational velocity) into account for the correct interpretation of the OV z phenomenon.

Conclusions. In general, the OV z stars appear to be on, or very close to, the ZAMS, but there are some examples where the Vz classification does not necessarily imply extreme youth. In particular, the presence of OV z stars in our sample at more evolved phases than expected is likely a consequence of modest O-star winds due to the low-metallicity environment of the LMC.

Reference: AA/2013/22798
Status: Manuscript has been submitted

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