Highlights on Spanish Astrophysics IX, Proceedings of the XII Scientific Meeting of the Spanish Astronomical Society held on July 18 – 22, 2016, in Bilbao, Spain. S. Arribas, A. Alonso-Herrero, F. Figueras, C. Hernández-Monteagudo, A. Sánchez-Lavega, S. Pérez-Hoyos (eds.)

Early-type massive stars in Carina Nebula within the Gaia-ESO Survey.

S.R. Berlanas[1,2], A. Herrero[1,2], F. Martins[3], S. Simón-Díaz[1,2], L. Mahy[4], R. Blomme [5], and the GES WG-13

[1] Instituto de Astrofísica de Canarias, 38200 La Laguna, Tenerife, Spain
[2] Departamento de Astrofísica, Universidad de La Laguna, 38205 La Laguna, Tenerife, Spain
[3] LUMP, Université de Montpellier, CNRS, Place Eugène Bataillon, F-34095 Montpellier, France
[4] Institut d Astrophysique et de Géophysique, Université de Liège, Bât B5C, Allée du 6 Août 17, 4000 Liège, Belgium
[5] Royal Observatory of Belgium, Ringlaan 3, 1180 Brussels, Belgium

Abstract

The Gaia-ESO Survey (GES) is obtaining high quality spectra of $\sim 10^5$ stars in our Galaxy, providing an homogeneous and unique overview of all the main components of the Milky Way, its formation history and the evolution of young, mature and ancient Galactic populations. Our group is in charge of the early-type massive stars that define the youngest population in the survey. In this contribution, we present the results of the quantitative spectroscopic analysis of O-type stars in the Carina Nebula within the Gaia-ESO Survey. For this aim, we have used FASTWIND and CMFGEN stellar atmosphere codes, providing stellar parameters for the current sample (GES data release iDR4).

1 Introduction

The Gaia-ESO Survey is covering the main components of the Milky Way using VLT-FLAMES, providing an homogeneous overview of the kinematics and chemical composition of our Galaxy. Open Clusters are useful tools for this aim, where it is possible to study stellar populations of different ages in different evolutionary stages. Combined with Gaia astrometry, this survey will help us to understand the formation history and evolution of young, mature and ancient Galactic populations.

The Carina Nebula Association represents a unique region to study Galactic massive stars with FLAMES. On the one hand, is one of the most massive association at a nearby distance $\sim$ 2.3 kpc [11] where is expected to obtain spectra for hundreds of massive stars. On the other hand, there is no systematic analysis of the stellar parameters in the association, that will be an important contribution of the Gaia-ESO Survey. The analysis of the Carina massive stellar population will be highly relevant for problems like the Initial Mass Function [3], [1], the detailed chemical composition and evolution (see [9] in Orion) or the stellar multiplicity [8].

2 Gaia-ESO spectra

The Gaia-ESO Survey (GES) is obtaining spectra using the Giraffe and UVES instruments, and for early type stars in Trumpler 14 cluster are employing four Giraffe setups (HR03/ 05A/ 06/ 14A) and the UVES CD3 (520-nm setting). Unfortunately, the Hγ line is not covered in the Giraffe setting, which provides most of the early-type spectra. This is a problem for our spectroscopic analysis, due to its importance on the accurate gravity determination (is not affected by other broadening effects).

In order to know the real effects of the lack of this line, we decided to analyse 129 IACOB-OWN spectra, which have a full wavelength coverage in the optical range, but using different line sets. In Figure 1 we represents the errors obtained for the effective temperature (Teff), gravity (logg), wind strength parameter (logQ, see [5]) and He abundances using (a) all the lines available on the IACOB-OWN spectra (in blue), (b) using only the lines available on the GES spectra (in orange) and (c) adding the Hγ line to them (in purple). It is clear that adding this line, we are improving significantly the GES O-type parameters determination. The effect is particularly relevant for gravity, and therefore the derived spectroscopic mass. Based on these results, the GES Working Group 13 on massive stars proposed the addition of the HR4 grating to the observations, covering the Hγ line. This proposal was accepted by the GES Steering Committee and the ESO, and we have just received the new data, whose analysis is now started.

3 Spectroscopic analysis

In the iDR4 we have 14 Carina early-type stars suitable for our analysis. Using automatized tools for the determination of stellar parameters (IACOB-GBAT [10]) and FASTWIND stellar models [12], [6] we have obtained the fundamental parameters of all of them (rotational velocities, temperatures, gravities, He abundances and Q parameter). In Figure 2 these stars are placed on a Hertzsprung-Russell diagram where evolutionary tracks of stars of various masses from [2] are plotted. 3 of the stars are placed below the ZAMS, which could be due to a binary nature or a wrong distance determination. The new data provided by Gaia will help us to settle this point.

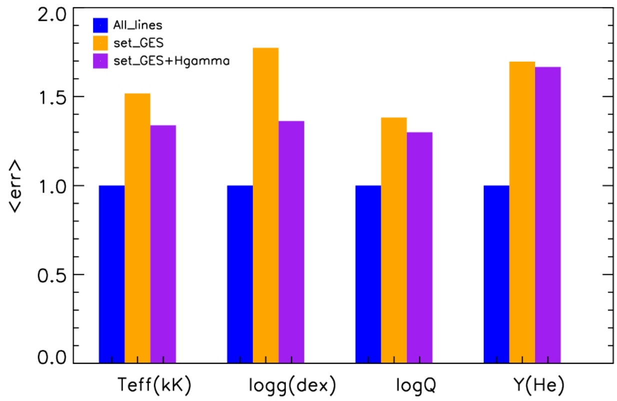

Figure 1: Histogram of the errors obtained for Teff, logg, logQ and He abundances using all the lines available on the IACOB-OWN spectra (in blue), using only the lines available on the GES spectra (in orange) and adding the Hgamma line to them (in purple). Values have been normalized to those obtained with the whole line set available (the blue bars).

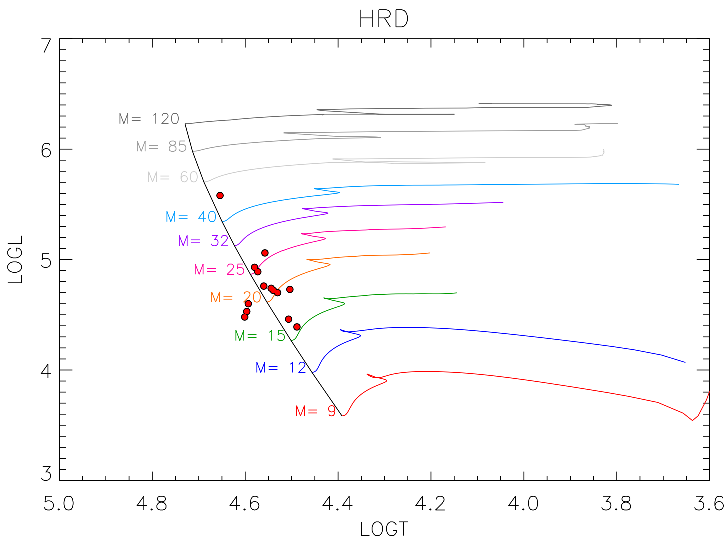

Figure 2: HR diagram of the sample of O-type stars (filled red circles) in Trumpler 14, where the evolutionary tracks of various masses from Ekström et al. 2012 are plotted (V/Vc=0).

4 FASTWIND vs CMFGEN

It was found recently by other authors that gravities determined using FASTWIND were systematically lower by 0.12 dex compared to CMFGEN [4]. In the GES WG-13 there are 2 groups analyzing O-type stars but using different stellar atmosphere codes: FASTWIND and CMFGEN, so we have compared results from both groups in order to confirm or reject this difference. Note however that, different to [4], our results have been obtained by two different groups. Taking into account that errors in the projected rotational velocity (vsini) affect the determination of logg [7], we have analyzed the sample from Section 3 but using now the vsini considered by the CMFGEN group in order to compare only codes. We do not obtain a clear systematic effect on the gravity (see Figure 3) and thus we can not confirm the results from [4]. The new data of the imminent iDR5 will provide us with a bigger sample to corroborate it.

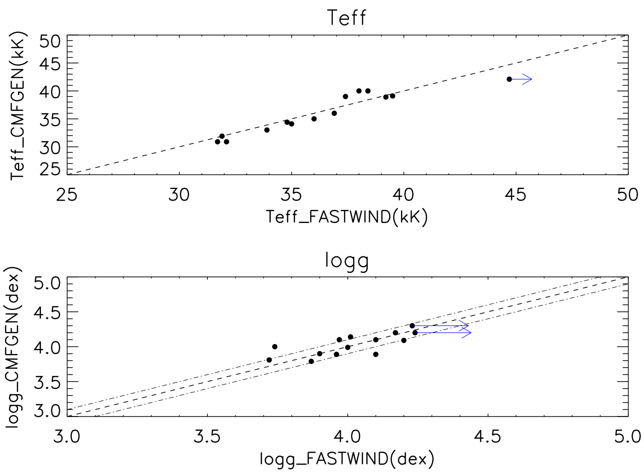

Figure 3: Comparison of effective temperatures and gravities obtained using FASTWIND and CMFGEN stellar atmospheres codes and considering the same vsini data. Blue arrows indicate lower limit values.

References

[1] Crowther et al. 2010, MNRAS, 408,731

[2] Ekström et al. 2012, A&A 537, A146

[3] Figer, D.F. 2005, Nature, 434, 192

[4] Massey, P. 2012 ApJ, 748, 96

[5] Puls et al. 1996, A&A, 305, 171

[6] Puls, J., Urbaneja, M.A., Venero, R. et al. 2005, A&A, 435, 669

[7] Sabín-Sanjulién, 2014, PhD, U. La Laguna

[8] Sana & Evans 2011, Proceedings IAU Symposium No. 272

[9] Simón-Díaz,S. 2010, A&A 510, A22

[10] Simón-Díaz,S. 2011, JPhCS, 328A, 2021S

[11] Smith, N. 2002, MNRAS, 337, 1252

[12] Santolaya-Rey, A.E., Puls, J., Herrero, A. 1997, A&A, 323, 488