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The Gaia-ESO Survey and Massive Stars

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Abstract. As part of the Gaia-ESO Survey (GES), a number of clusters will be observed that were chosen specifically for their massive-star content. We report on the procedures we followed to determine the stellar parameters from the massive-star spectra of this survey. We intercompare the results from the different techniques used by the nodes of our group to determine these parameters and discuss some of the problems encountered. We present preliminary results for NGC 6705, NGC 3293, and Trumpler 14. We study microturbulence in A-type stars, we use the repeat observation to investigate binarity, and we determine cluster membership from the radial velocity information. The large number of massive-star spectra obtained by the Gaia-ESO Survey will allow us to critically test stellar evolution modelling.

Keywords. surveys, stars: abundances, stars: atmospheres, binaries: spectroscopic, stars: early-type, stars: statistics, open clusters and associations: Trumpler 14, NGC 3293, NGC 6705

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1. Introduction

The Gaia-ESO Survey† (GES) groups over 400 Co-Investigators in a project led by Gerry Gilmore and Sofia Randich. It is an ambitious project to study the formation and evolution of the Milky Way and its stellar populations. The FLAMES instrument on VLT-UT2 is being used during 300 nights (spread over 5 years) to collect about 100 000 Giraffe spectra and 10 000 UVES spectra. As part of the survey, a number of clusters are observed that were chosen specifically for their massive-star content. As members of GES Workgroup 13 (WG13), we are responsible for the spectrum analysis of the O-, B- and A-type stars, as well as the analysis of stars in older clusters that have been observed with the hot-star Giraffe gratings.

WG13 is further split up into a number of groups (called nodes, see Table 1) that analyze the spectra with their specific techniques and codes. Overlap between the nodes is encouraged. Once each group has determined the stellar parameters, the results are combined into recommended parameters. For the recommended parameters, preference is given to the ROB, Liège or IAC results, as they are based on more specific atmosphere models and spectra. When these values are not available (which occurs in the majority of the cases!), the ROBGrid values are used. Using these recommended parameters, each

† `http://www.gaia-eso.eu/`

Table 1. Five nodes contribute to the analysis of the O-, B- and A-type stars.

Node	Details	Spectral type
ROB	Refined grid of Kurucz ATLAS9 models; LTE spectrum synthesis; compare equivalent widths and detailed shapes of selected lines	A stars
Liège	Kurucz or Tlusty models; NLTE spectrum synthesis; compare spectral line shapes	B stars
IAC	FASTWIND models; χ^2 fitting to spectral line shapes	O stars
ROBGrid	Model grids from the literature; χ^2 fitting of full spectral range	all stars (hot+cool)
IAA	Spectral classification of O-type stars	O stars

node then determines the abundances. Currently, we determine iron abundances in A-stars, He, Mg and Si abundances in B-stars, and He abundances in O-type stars.

2. Preliminary results

Comparison nodes. The results of the different nodes are compared to one another, to judge the uncertainty in the parameters. The effective temperatures are generally in good agreement between ROBGrid and the other nodes, except for ROB. The agreement in gravity between ROBGrid and the other nodes is not very good.

Trumpler 14. For all clusters, we analyse plots of the so-called "spectroscopic" HR diagram (Langern & Kudritzki 2014). Specifically for Trumpler 14, the isochrones show a spread in ages, suggesting star-formation during several Myr. A number of ROBGrid determinations fall below the ZAMS because they have incorrect log g values.

Cluster membership NGC 3293. Starting from histograms of the radial velocities derived from the GES spectra, we select those stars with the most frequently occurring radial velocities, and map them back on to their sky coordinates. These presumed members cover a large range in distances from the cluster centre. This suggests that NGC 3293 is larger than assumed so far.

Microturbulence in A-type stars. The ROB node also determined the microturbulence for A-type stars in NGC 3293 and NGC 6705. The highest values for microturbulence are found around 8000 K.

Binarity in NGC 3293. A repeat observation made about 1 month later allows us to look for binarity in these clusters. We measure the radial velocity difference with a cross-correlation technique and test its significance using Monte-Carlo simulations. Specifically for NGC 3293, about 5 % of the stars show clear signs of binarity. To derive the true binary fraction, this number needs to be corrected for the fact that we have only two epochs available. This correction factor is however poorly defined with only two epochs.

3. Conclusions

The Gaia-ESO Survey data will:

- provide critical tests for hot-star evolution,
- provide masses, radial velocities, binary fraction information for cluster studies,
- give specific information about A-, B- and O-type stars,
- contribute to the determination of Galactic abundance gradients.

However, to achieve these goals, the remaining discrepancies among the various node results will need to be clarified.

References

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