Gaia-ESO Survey: the First Release from the Analysis of UVES Spectra of FGK-type Stars

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Abstract. The Gaia-ESO Survey is obtaining medium- and high-resolution spectra of $\sim 10^5$ stars. About 5000 FGK-type stars are being observed in high-resolution with UVES. All the spectra are being analyzed by the Gaia-ESO Survey consortium, and the resulting advanced data products will be released to the community. The first public release of these products is expected in 2014. Results from the analysis of the UVES spectra will include atmospheric parameters and abundances of more than 20 different elements in ~ 1500 stars. This contribution presents a summary of the analysis strategy applied to these data. We also describe the products from this analysis that will be made available in the first Gaia-ESO public release of advanced data products.

1. The Gaia-ESO Survey

The Gaia-ESO Survey is a public spectroscopic survey that is obtaining medium- and high-resolution spectra of more than 10^5 Galactic stars (Gilmore et al. 2012; Randich & Gilmore 2013). Observations are conducted with the FLAMES multi-fiber facility (Pasquini et al. 2002) at the VLT, Paranal Observatory, Chile.

Stars from all major Galactic components (halo, bulge, thin and thick disk) and from a large sample of open clusters (> 50) are being observed. Targets include early- and late-type stars, metal-poor and metal-rich stars, dwarfs, giants, and pre-main sequence stars. The Survey aims to understand how the Galaxy formed studying how all of its stellar populations formed and evolved. The Gaia-ESO Survey will complement the results of the ESA Gaia space mission. With our ground-based observations we can provide better radial velocities, detailed chemical abundances, and in some cases additional spectroscopic data products such as chromospheric activity indicators.

The astrophysical results obtained by the Gaia-ESO consortium will be made available to the community through public releases of advanced data products. These releases will be accessible through a dedicated Gaia-ESO Survey science archive[1] hosted by the Wide Field Astronomy Unit (WFAU) of the Institute for Astronomy, Royal Observatory, Edinburgh, UK, and through the ESO data archive[2].

2. The UVES spectra of FGK-type stars

Of the 10^5 stars targeted by the Survey, a subsample of about 5000 FGK-type stars are being observed with UVES (Dekker et al. 2000) at R = 47 000 and with the U580 set up ($\lambda\lambda$ = 470-684 nm). Data reduction of the UVES data is done with the ESO pipeline (Sacco et al. 2014). Most of the remaining stars are observed with Giraffe in medium-resolution, although some early-type stars are also observed with UVES and the U520 set up.

The main late-type targets observed with UVES are: 1) solar neighborhood FG-type dwarfs (within 2 kpc) and 2) clump giants in old and intermediate-age open clusters (age > 0.1 Gyr). Additional targets include: giants in the inner and outer disk, in the bulge, and in globular clusters; dwarfs in young and intermediate-age clusters; dwarfs and giants in fields observed by the CoRoT satellite (Baglin et al. 2006).

3. Multiple analysis strategy

The full sample is analyzed in parallel by 13 Nodes using different state-of-the art spectrum analysis methodologies (see Smiljanic et al. 2014, for a full description). This strategy has two main advantages: 1) No single pipeline is optimal for all stellar types (e.g., giants vs. dwarfs, metal-poor vs. metal-rich stars). With multiple pipelines, we can identify those that provide the best results in different regions of the parameter space; and 2) With multiple pipelines, we can quantify method-dependent effects, measuring the real precision of spectroscopic analyses.

The efficiency of the pipelines is judged against the Gaia benchmark stars, a set of bright stars for which well-determined $T_{\rm eff}$ and $\log g$ values are available from direct methods, independent from spectroscopy (see e.g. Jofré et al. 2014). An additional set of calibration open and globular clusters is also used for quality control. In this case, we investigate if the pipeline parameters $T_{\rm eff}$ and $\log g$ are physically sound and compare well to theoretical isochrones for the age and metallicity of the cluster.

The results are separately evaluated in three different regions of the parameter space: 1) *metal-rich dwarfs* with [Fe/H] > -1.00 and $\log\ g > 3.5$; 2) *metal-rich giants* with [Fe/H] > -1.00 and $\log\ g \leq 3.5$; and 3) *metal-poor stars* with [Fe/H] ≤ -1.00. Pipeline results that successfully pass these tests are combined to produce a final set of *recommended atmospheric parameters* using weighted-medians. The method-to-method dispersion is also computed and used as an indicator of the results precision. The accuracy of the results is estimated from the average difference between the final recommended atmospheric parameters of the

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[1] http://ges.roe.ac.uk/index.html

[2] http://archive.eso.org/wdb/wdb/adp/phase3_spectral/form?phase3_collection=GaiaESO

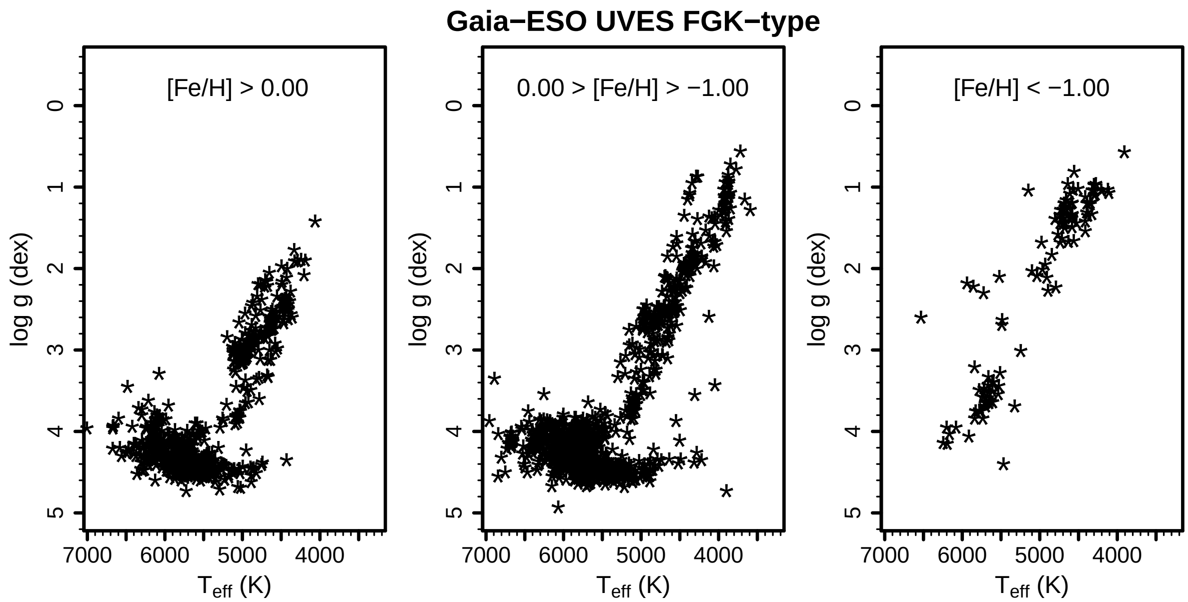

Figure .1: The $T_{\rm eff}$-log g diagram for the FGK-type stars with UVES spectra from the Gaia-ESO Survey for which analysis has been completed. Three panels are shown where the stars are divided according to metallicity.

benchmark stars and the fundamental ones used as reference. The analysis is described in detail in Smiljanic et al. (2014).

4. Atmospheric parameters and abundances

The analysis of all data obtained up to the end of June 2013 is completed. Additional data obtained between July and December 2013 is under analysis. At the moment, atmospheric parameters (effective temperature, surface gravity, metallicity, and microturbulence velocity) were derived for 1301 stars. The distribution of these stars in the $T_{\rm eff}$-log g diagram is shown in Fig. 1. Abundances for a total of 24 elements were derived: C, N, O, Na, Mg, Al, Si, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Y, Zr, Mo, Ba, Nd, and Eu (Smiljanic et al. 2014). In this sample, 1079 stars have abundances of at least 15 different elements and 1203 stars have abundances of at least 10 different elements.

The list of abundances includes elements formed in different nucleosynthetic processes, highlighting the value of the results being produced by the Gaia-ESO collaboration.

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