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The relevance of the Gaia-ESO Survey on the Galactic metallicity gradient: Focus on open clusters

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Abstract. An overview of the Gaia-ESO Survey project is presented, with focus on open star clusters and their use to trace the radial metallicity gradient in the thin disc.

1. The Gaia-ESO Survey

The Gaia-ESO Survey (GES- Gilmore *et al.* 2012; Randich *et al.* 2013) is a large public spectroscopic survey that has completed 340 observing nights on the ESO-VLT. GES used FLAMES to target 10^5 field stars in the bulge, the thick and the thin discs, and the halo, as well as a significant sample of open star clusters (OCs), providing a homogeneous overview of the distributions of kinematic, metallicity, and elemental abundances. Observations have been carried out using both Giraffe and UVES in parallel (Pancino *et al.* 2017). The analysis of the spectra yields radial and rotational velocities, stellar parameters and properties, metallicity and a few abundances for Giraffe targets; for the stars observed at high resolution with UVES detailed abundances for up to 32 chemical elements are also measured. The parameters and abundances of all the sample stars are homogenized to the same scale using a variety of calibrators.

GES has several advantages for the investigation of the radial metallicity gradient. Among them we mention that it is the largest stellar survey performed on a 8m class telescope, hence reaching fainter magnitudes and larger distances than other surveys. It is also the only one that has targeted all stellar populations, from pre-main sequence stars to evolved giants, from O-type stars to cool M dwarfs, from very young star forming regions (SFRs) to very old populations.

2. Open Clusters in the Gaia-ESO Survey

As mentioned above, GES has put a special emphasis on OCs, in order to address a variety of science goals, including cluster formation and dynamical evolution, stellar physics, and thin disc formation and evolution. The cluster sample is not only important to derive the gradient, but also to calibrate stellar ages (Randich *et al.* 2018), which are in turn fundamental to investigate the evolution of the gradient. GES observations have covered 65 and eight science and calibration OCs, respectively, while data for another 20 clusters have been retrieved from the ESO archive and homogeneously analyzed with the GES sample. The OC sample well covers the parameter space, distance from the Sun, age, and Galactocentric distance, in particular. Within each cluster several secure members are observed with UVES, to provide robust median metallicities and abundances (e.g., Spina *et al.* 2017 –S17; Magrini *et al.* 2017).

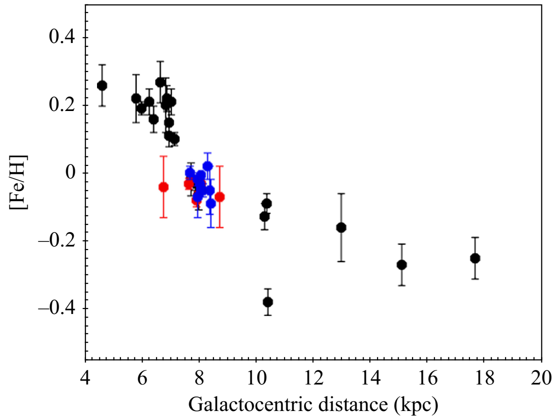

Figure 1. Update of Figure 5 in S17. [Fe/H] vs. Galactocentric distance for 38 OCs included in GES analysis cycle 5. Red/blue/black symbols: SFRs; age 10–100 Myr; age > 100 Myr.

3. A few highlights

Science analysis based on the first five cycles has confirmed the huge potential of GES OC sample to address the issue of the radial metallicity gradient (e.g., Jacobson *et al.* 2016). In particular, GES crucially allows the determination of the present-day metallicity distribution: S17 derived that based on the young clusters and SFRs analyzed in the fourth GES cycle, a few of which are located in the inner parts of the disc. Most surprisingly they found that all the young regions have close-to-solar or slightly sub-solar metallicities. At variance with the older OCs, the distribution traced by the young ones is almost flat, with the innermost SFRs having [Fe/H] values $0.10 - 0.15$ dex below the older counterparts located at similar Galactocentric radii (see also Figure 1). These findings favour models that predict a flattening of the radial gradient with time. On the other hand, the decrease of the average [Fe/H] at young ages is not easily explained by the models, and reveal a complex interplay of the several process that controlled the recent evolution of the thin disc.

4. Gaia-ESO and *Gaia*

The final analysis of GES will be completed soon, yielding homogeneous metallicities for the full sample of OCs (science, calibration, and archival) for a total of more than 90 objects. At the same time *Gaia* DR2 will allow the homogeneous determination of distances and ages, as well as to integrate the cluster orbits using proper motions. The joint dataset will allow further insights on the gradient, its time evolution, and dependence on the azimuth and height on the plane.

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