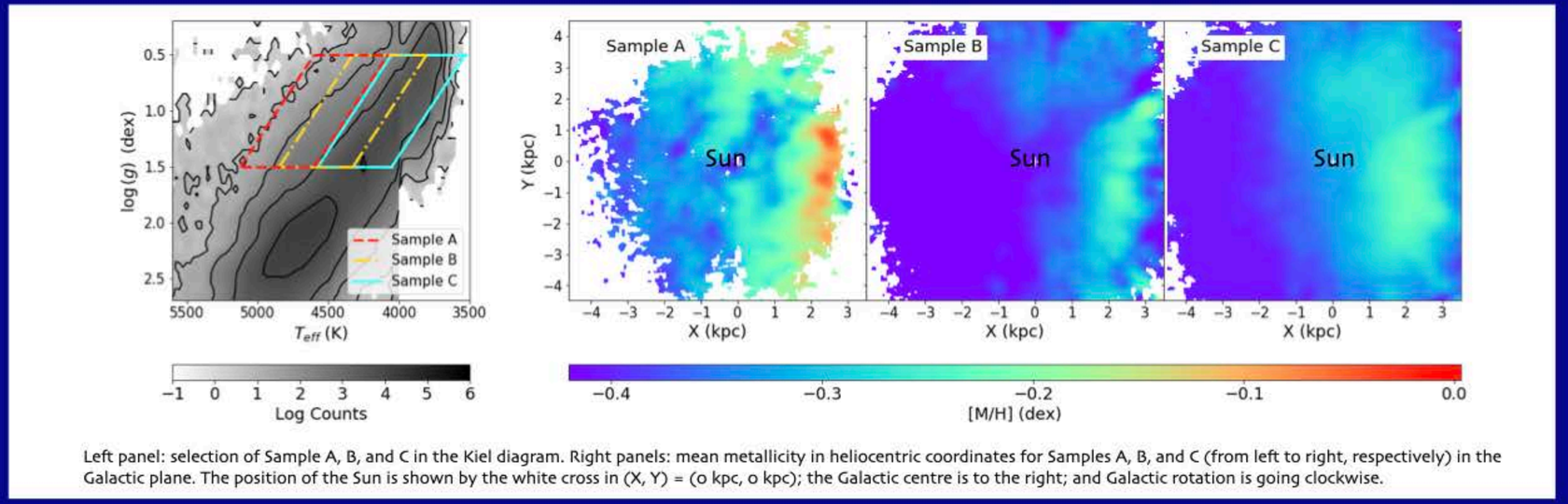
# Chemical footprints of the Galactic spiral arms revealed by Gaia DR3

E. Poggio, A. Recio-Blanco, P. A. Palicio, P. Re Fiorentin, P. de Laverny, R. Drimmel, G. Kordopatis, M. G. Lattanzi, M. Schultheis, A. Spagna, E. Spitoni




Left panel: selection of Sample A, B, and C in the Kiel diagram. Right panels: mean metallicity in heliocentric coordinates for Samples A, B, and C (from left to right, respectively) in the Galactic plane. The position of the Sun is shown by the white cross in (X, Y) = (0 kpc, 0 kpc); the Galactic centre is to the right; and Galactic rotation is going clockwise.

- We select **three different samples** of bright giants (Sample A, B, C) using GSP-Spec effective temperatures and surface gravities fom the GSP-spec module (Recio-Blanco et al., 2023) in Gaia Data Release 3 (Gaia Collaboration, Vallenari et al. 2023). We **map the mean metallicity of stars in the Galactic disc** for the three samples.

- Some of the features presented by the maps are know, such as the radial metallicity gradient of the Milky Way's disc (i.e. overall decrease of the mean metallicity towards the outer parts of the disc, at X<0)

- The maps also reveal some **new features**, apparent as **spatially-dependent metallicity substructures on top of the radial metallicity gradient**, which become more pronounced and structured as we move from Sample C to Sample A

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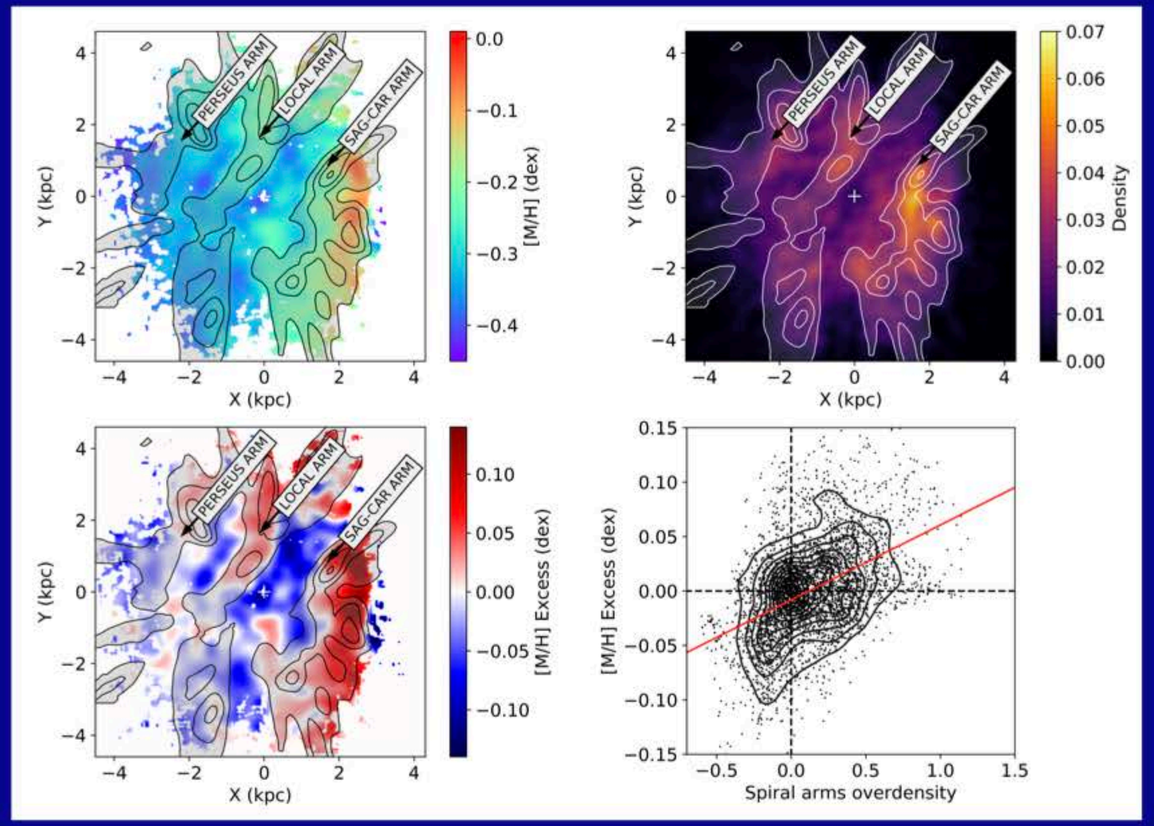
- The comparison between the metallicity map of Sample A and the segments of the nearest spiral arms in the Galaxy (grey shaded areas) indicates that **the regions inside the spiral arms are typically more metal-rich than those in the interarm regions** (upper left panel)
- This is confirmed by the metallicity contrast (lower left panel), which is statistically correlated with the spiral arms' position (lower right panel). (More details in Poggio et al. 2022)
- A similar signature has been predicted by N-body simulations (e.g. Khoperskov et al. 2018) and chemical evolution analytic models (e.g. Spitoni et al. 2019)

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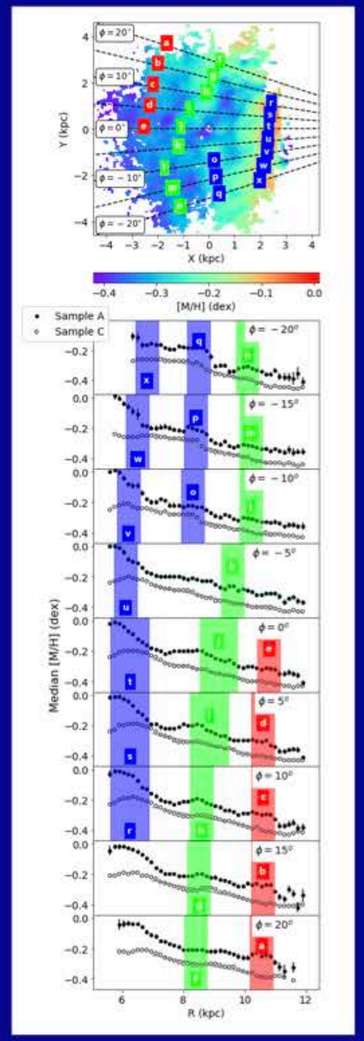


- We dissect the Galactic plane into slices in Galactic azimuth (Fig. 3, upper panel). For each slice, we calculate the median metallicity for Sample A and Sample C as a function of distance from Galactic center R (Fig. 3, lower panels).

- **Sample A** (black dots) **exhibit peaks of higher metallicity (~0.05–0.1 dex in amplitude), superimposed on a global decrease as a function of R.** Such undulations are typically located in correspondence with the spiral arms' locations in the Galactic disc, and are the projection on the radial direction of the metal-rich features observed in the XY maps.

- In contrast, for **Sample C** (open circles), a smooth radial gradient is apparent. However, **the slope of the radial metallicity gradient gradually varies as a function of azimuth**, being typically steeper for positive azimuths (i.e. in the direction of Galactic rotation). The obtained values are reported in the Table below.

**Table 1.** Radial gradient for Sample C in different azimuthal bins, as shown in Fig. 3, assuming a linear model.

| $\phi$ (deg) | Slope (dex kpc$^{-1}$) | Intercept (dex) |
|---|---|---|
| $-20 \pm 5$ | $-0.054 \pm 0.002$ | $0.15 \pm 0.02$ |
| $-15 \pm 5$ | $-0.053 \pm 0.002$ | $0.13 \pm 0.02$ |
| $-10 \pm 5$ | $-0.046 \pm 0.002$ | $0.07 \pm 0.02$ |
| $-5 \pm 5$ | $-0.041 \pm 0.002$ | $0.03 \pm 0.01$ |
| $0 \pm 5$ | $-0.043 \pm 0.002$ | $0.04 \pm 0.01$ |
| $5 \pm 5$ | $-0.042 \pm 0.002$ | $0.04 \pm 0.02$ |
| $10 \pm 5$ | $-0.040 \pm 0.002$ | $0.03 \pm 0.02$ |
| $15 \pm 5$ | $-0.039 \pm 0.002$ | $0.03 \pm 0.02$ |
| $20 \pm 5$ | $-0.036 \pm 0.002$ | $0.01 \pm 0.02$ |

**Notes.** Only stars with $R > 7$ kpc are considered here, so as to avoid selection effects in the inner regions due to extinction, as well as $R < 11$ kpc, to avoid low statistics regions. The corresponding table for Samples A and B is not presented here due to the large metallicity variations related to spiral arms, which invalidate the assumption of a linear model.

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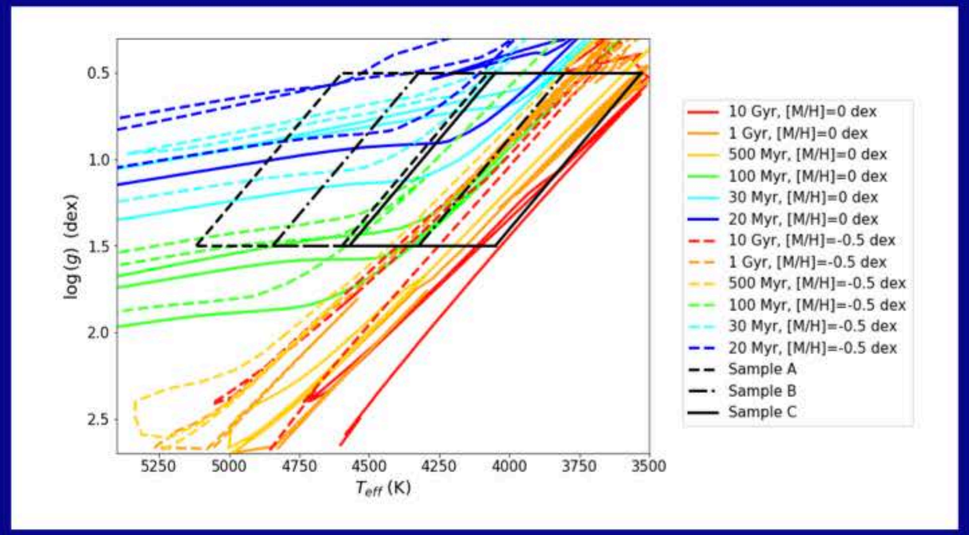
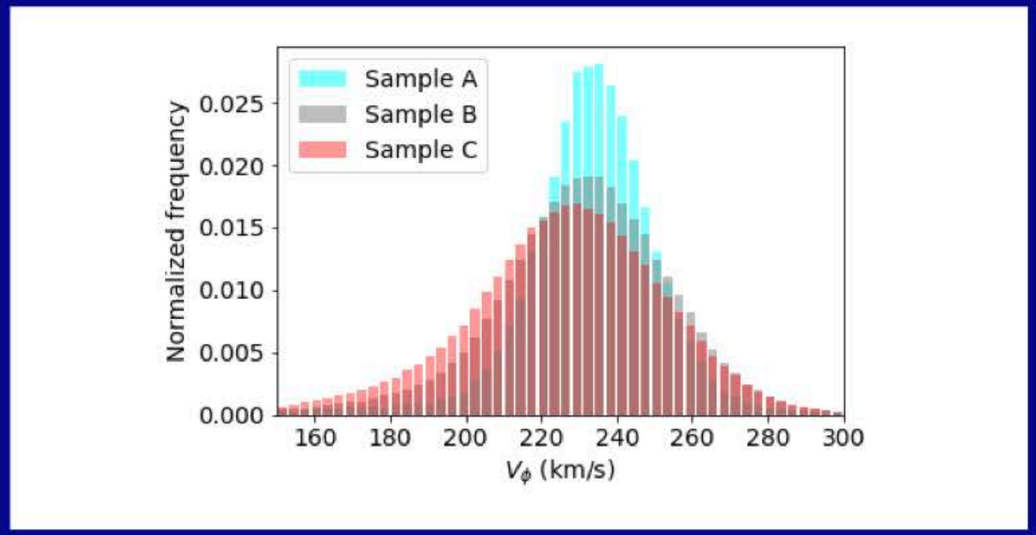
**Sample A is expected to be younger than Sample C**, based on:

1. A comparison with the PARSEC isochrones (Bressan et al. 2012, Chen et al. 2014, Pastorelli et al. 2019) and our selected areas in the Teff-logg space (see left plot below)
2. The observed kinematic properties of the three samples, such as typical azimuthal velocity and velocity dispersions (see right plot below)

Sample B is expected to be intermediate between the two, containing a mixture of young and old stellar populations.

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**Paper:**


- Poggio, E., Recio-Blanco, A., Palicio, P. A., et al. 2022, A&A, 666, L4


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