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Stellar Parameters, Chemical composition and Models of chemical evolution

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Abstract. We present an in-depth study of metal-poor stars, based high resolution spectra combined with newly released astrometric data from Gaia, with special attention to observational uncertainties. The results are compared to those of other studies, including Gaia benchmark stars. Chemical evolution models are discussed, highlighting few puzzles that are still affecting our understanding of stellar nucleosynthesis and of the evolution of our Galaxy.

Keywords. stars: abundances, Galaxy: abundances, Galaxy: evolution.

1. Observations and abundance determination

The stellar spectra considered in this work have been obtained with the echelle spectrograph SOPHIE on the 1.93m telescope of OHP (France) which has a resolving power of R = 75 000 and covers the wavelengths range 4400 – 6800 ÅÅ. The atmospheric parameter determinations are from Mishenina *et al.* (2017). The abundances of the investigated elements Li, O, Na, Mg, Al, Si, Ca, Ni, Co, Mn, Y, Zr, Ba, La, Ce, Nd, Sm, Eu and Gd were determined for our target stars under LTE and NLTE approximations.

2. Chemical evolution

The theoretical galactic chemical evolution (GCE) calculations compared with these observations have a number of uncertanties and approximations to take into account, possibly leading to different results.

In the Fig. 1, we present a comparison between our results, and a number of GCE models produced using different codes. The black lines presented code OMEGA, a one-zone model (solid and dashed lines correspond to the massive star yields and the no-cutoff prescriptions for the stellar remnant masses, respectively. The black dotted lines represent NuGrid Set 1 extension massive star yields Côté *et al.* (2016). The GCE model predictions by Bisterzo *et al.* (2014) are shown with red lines (solid line - thin disk, dashed line - thick disk, dashed-dotted line - halo). The green solid line the solar neighbourhood

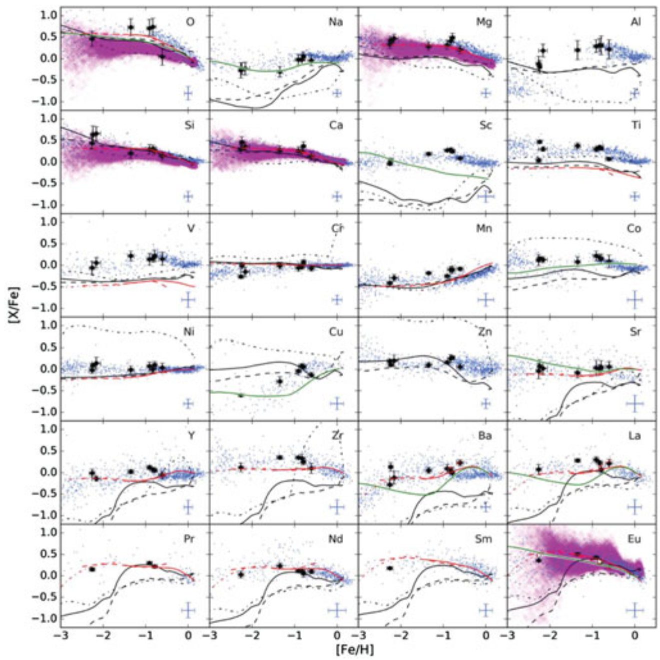

Figure 1. The trends of [El/Fe] vs. [Fe/H] for our stellar sample are marked as full symbols, for other studies as blue and magenta symbols.

chemical evolution model described by Hughes *et al.* (2008), realised with the GEtool software package. Results from the inhomogeneous GCE model by ICE code Wehmeyer, Pignatari & Thielemann (2015) are shown with magenta crosses. Details for the different codes and setup of the GCE models are given in Mishenina *et al.* (2017).

3. Results and Conclusions

– The abundances for 14 to 27 elements were derived using both LTE and NLTE approaches for 10 stars.

– The main sources of GCE uncertainty are from stellar yields and from different assumptions in GCE simulations, e.g., the stellar mass range on which stellar yields are applied, the interpolation scheme between stellar models, the stellar initial mass function, the star formation history, the star formation efficiency (related to the gas fraction), the treatment of SNe Ia, the astrophysical sites for heavy elements, and the galaxy framework (single- or multi-zone).

– Predictions from different GCE models produce a scatter larger than observational errors for many elements. Finally, we confirm the well-known difficulties in reproducing the evolution of [Sc/Fe], [Ti/Fe], and [V/Fe].

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