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PRECISE MAGNESIUM ABUNDANCES IN THE METAL-RICH DISK

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Abstract. The α - elements abundance provides an important fossile signature in galactic archeology to trace the chemical evolution of the different disk populations. However, a precise abundance estimation in the metal-rich disk ([M/H] $\geq$ 0 dex) is still complex due to the presence of blended lines and the difficulty in the continuum placement. We present a detailed Mg I abundance analysis for a sample of 2210 stars in the solar neighborhood, mostly dwarfs, observed by HARPS (ESO spectrograph ; R $\sim$ 115000) and parametrised by the AMBRE project. The abundances were derived using the the automatic spectral synthesis code GAUGUIN, analysing nine magnesium spectral lines in the optical range. Applying a better continuum treatment, we observe both the chemical distinction between thin-thick disk populations and a decreasing trend in the magnesium abundance even at supersolar metallicities. A careful continuum placement in the normalization of the observed spectra could throw some light on chemodynamical relations (e.g. [Mg/Fe] as a good age proxy for the thin disk or the contribution of radial migration in the solar neighborhood).

Keywords: Galaxy - stars: abundances , Galaxy: disk , Method: data analysis

1 Automatic magnesium abundance analysis

From the AMBRE:HARPS spectra sample (De Pascale et al. 2014), we have derived and analysed automatically the [Mg/Fe] abundances over nine Mg I spectral lines in the optical range, via the optimization method GAUGUIN (Bijaoui et al. 2012). We have observed different behaviours depending on the intensity of the line, allowing us to classify them in two categories: *weak* (4730.04, 5711.09, 6318.7, 6319.24 & 6319.49 Å) and *intense* (5167.3, 5172.7, 5183.6 & 5528.4 Å) lines. We have performed an in-depth analysis of each line separately, studying the different sources of possible uncertainties when deriving the chemical abundances.

1.1 *Sensitivity to stellar rotation*

The dispersion on the [Mg/Fe] abundance measurement, as a function of metallicity, is dominated by the stellar rotation, particularly in the weak lines, since the intense lines present more precise thin and thick disk sequences. We have observed this rotation effect on the intense lines at higher rotational velocities, but to a lesser degree. This results highlights the importance of a correct treating of the stellar rotation when using weak lines. Otherwise, choosing more intense lines or restricting the analysis of cooler stars (for which the rotational velocity is lower) will minimize the effects. We keep only slow-rotating stars, retaining spectra with $\mathrm{FWHM}_{CCF}{}^{*} \leq 8$ km s^{-1} for the intense lines, whereas only $\mathrm{FWHM}_{CCF} \leq 7$ km s^{-1} for the weak lines.

1.2 *Normalization problems: importance of the continuum placement*

In large spectroscopic stellar surveys, an automatic adjustment of the continuum is performed over the observed spectrum for every stellar type, via few iterations, searching the possible line-free or less contaminated zones, and fitting the ratio between the synthetic and the observed flux over a local interval around the line. For each line, we have applied different local normalization intervals (from short ranges, $\Delta\lambda_{norm} \sim 2$Å, to the whole window of the grid, $\Delta\lambda_{norm} \sim 70$Å), and studied the random errors caused by the change in the line χ^2 fitting due to the continuum placement.

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[*] radial velocity cross-correlation function; estimator provided by the AMBRE program.

We found that the normalization procedure has a direct impact on the derived abundance from every magnesium spectral line and depends on the stellar type, leading to different trends in the metal-rich regime ([M/H] $\geq$ 0 dex) and in the distinction between the thin-thick disk stellar populations. The normalization procedure needs to be optimized depending on the stellar type. Contrary to what has been done so far, the same procedure cannot be applied for every star since some abundance information might be lost.

2 Most precise Mg abundances in the Gaia era

It is shown in Fig. 1 the final stellar abundance ratios [Mg/Fe] vs [M/H], defined as the median abundance value from the multiple spectra of stars ($\geq$ 4 *repeats*), in which the abundance information from every line has been taken into account. For a given spectrum, a weighted mean (by the distance from the median abundance) was performed. For a given line and spectrum, we adopt the abundance which corresponds to the normalization interval that presents the lowest χ^2 fitting value. Fig. 1 shows a clear chemical distinction between the Galactic thin-thick disks populations (low- and high-[Mg/Fe] sequences, respectively) up to [M/H] $\sim +$ 0.1 dex.

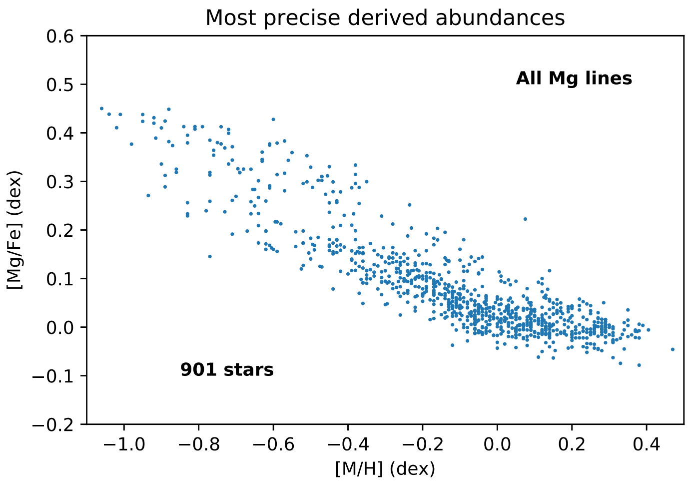

Fig. 1. Stellar abundance ratios [Mg/Fe] as a function of [M/H] following the quality criteria, taking into account the abundance information from all the studied Mg I spectral lines.

The second *Gaia* data release (*Gaia* DR2, Gaia Collaboration et al. 2018) has provided extremely precise and accurate astrometric information for millions of stars, allowing us to infer and discover the Galactic structure in unprecedented detail. For taking full advantage of these high-quality data, precise chemical abundances are strongly demanded in order to not to lose information about the different Galactic stellar populations and to improve our knowledge of the chemodynamical relations presented in the Galaxy.

3 Conclusions

The normalization procedure has a direct impact on the derived abundances and needs to be optimized depending on the stellar type, otherwise some abundance information might be lost. High-precision abundances, in combination with distances and kinematics from *Gaia*, are crucial to study the Galactic chemodynamical relations.

References

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