The AMBRE Project
Chemical tagging of the Galactic disc

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Chemical tagging of the Galactic disc

The Ambre Project

AMBRE A Galactic Archaeology project based on ESO archived HR spectra (de Laverny et al., 2013)

Main Goals

- Provide advanced ESO data products
- Homogeneous stellar parametrisation & chemical analysis
- Provide large data samples for Galactic/stellar studies
Chemical tagging of the Galactic disc

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Methodology

Parametrisation pipeline for V$_{rad}$, Teff, log(g), [M/H], [$\alpha$/Fe]

- MATISSE algorithm (Recio-Blanco et al., 2006)
- FGKM-type spectra grid (de Laverny et al. 2012)

Fully parametrised samples

- 6 508 FEROS spectra (Worley et al., 2012)
- 93 116 HARPS spectra (de Pascale+2014)
- 12 403 UVES spectra (Worley et al. 2016)

Warning: several repeats!
Chemical tagging of the Galactic disc

The Ambre Project

* On-the-fly line profile fitting ($\chi^2$ minimisation):
  $\rightarrow$ Iron-peak element abundances for 4 666 stars (Mikolaitis et al., 2016)

* GAUGUIN Gauss-Newton method (Bijaoui et al., 2012)
  $\rightarrow$ Li abundances for 7 300 stars (Guiglion et al., 2016)
Chemical tagging of the Galactic disc

The Ambre Project

Chemical tagging

* On-the-fly line profile fitting ($\chi^2$ minimisation):
  → Iron-peak element abundances for 4,666 stars (Mikolaitis et al., 2016)

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Chemical tagging of the Galactic disc

Iron-peak elements

LTE abundances for 4,666 stars: Mg, Mn, Fe, Ni, Cu, Zn

Chemical separation of the Galactic substructures

- Metal-poor thick disc: 6%
- Metal-rich thick disc: 6%
- Thin disc: 84%
- Low/High α halo stars: 3%
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Iron-peak elements

- Mn
- Ni
- Cu
- Zn

Thick metal-poor

Thick metal-rich

Thin disc

[Fe/H] vs. [Mn/Fe], [Ni/Fe], [Cu/Fe], [Zn/Fe] for different metallicities.
Clear Thin/Thick separation?

- Mg: YES
- Mn: Partly
- Ni: NO
- Cu: Partly ??
- Zn: YES!

Thick metal-poor
Thick metal-rich
Thin disc

Partly
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Iron-peak elements

Zinc – behaves like an $\alpha$ element

![Graph showing the relationship between [Zn/Fe] and [Fe/H] for different disc types: Thick metal-poor, Thick metal-rich, and Thin disc.](image)
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Iron-peak elements

Zinc behaves like an $\alpha$ element: Produced in massive stars

Very good tool to disentangle Galactic discs
Chemical tagging of the Galactic disc

Iron-peak elements

\[ \frac{[\text{Mn}]}{[\text{Mg}]} \rightarrow \text{Mn from SNIa} \quad \& \quad \text{Mg from SNII} \]

Very good chemical index to disentangle Galactic populations
Dispersions smaller than ~0.05dex → constraints for radial migration
Chemical tagging of the Galactic disc

Iron-peak elements

Comparison with Galactic chemical evolutionary models

Mg, Zn & Cu partially well reproduced
Larger discrepancies for Mn and Ni

![Graph showing comparisons between thin and thick disc models](image)
Chemical tagging of the Galactic disc

Iron-peak elements

Comparison with Galactic chemical evolutionary models

Better agreement if yields match Solar composition

Models from Kubryk et al., 2015
Chemical tagging

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→ Li abundances for 7,300 stars (Guiglion et al., 2016)
Chemical tagging of the Galactic disc

Lithium

Very high quality homogeneous NLTE $A(\text{Li})$ for 2264 dwarfs

Upper enveloppe: no Li depletion

AMBRE/Li sample
Chemical tagging of the Galactic disc

Lithium

Very high quality homogeneous NLTE $A$(Li) for 2264 dwarfs

Upper enveloppe: no Li depletion

Galactic Li enrichment

AMBRE/Li sample

Delgado-Mena et al. 2015
Lambert & Reddy 2004
Spite plateau
SBBN
Chemical tagging of the Galactic disc

Lithium

Lithium in Galactic populations: chemical separation

![Graph showing chemical separation of Galactic populations based on lithium content.](image)
Chemical tagging of the Galactic disc

Lithium

Lithium in Galactic populations

Metal + α rich: different Li history?

Internal Li destruction

Spite Plateau

Thick

Thin
Chemical tagging of the Galactic disc

Lithium

![Graph showing Lithium concentration vs. [M/H] for thick and thin components of the Galactic disc. The graph includes data points and trend lines indicating the Spite plateau and SBBN.]
Summary for lithium

- Clear distinct Li evolution in the thin and thick discs

- Thin disc: Li in the ISM increases with [M/H] up to Solar values. Li decreases at higher metallicities.

- Thick disc: Initial ISM Li enrichment ~ Spite Plateau. Small increase with [M/H].

- Metal+α-rich stars: More enriched than thin disc stars. Different chemical history?
Summary for iron-peak elements

- Thin/Thick discs well disentangled not only with $[\alpha/\text{Fe}]$
  but also with $[\text{Zn/Fe}]$ and $[\text{Mn/Mg}]$

- Very small dispersion in chemical species for both discs
  → efficiency of the radial migration

- Model comparison: lack of some theoretical yields?
Announcement

Science with Gaia

Astrometry & Astrophysics in the Gaia sky

IAU Symposium 330
Nice, 24-28 April 2017

https://iaus330.sciencesconf.org/

Important dates
- Abstract submission: December 4, 2016
- IAU grants: November 1st, 2106