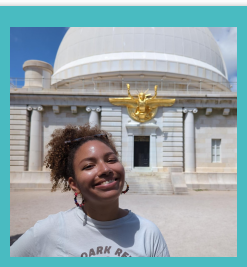
Unveiling the origin of the most metal-poor disc stars with SOPHIE@OHP, ESPaDOnS@CFHT, and UVES@VLT



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Very metal-poor stars (VMP, [Fe/H] <-2 dex) are crucial to reconstruct the assembly of the Milky Way, as their chemical and kinematical signatures retain the **fossils of the early Universe.** They are **expected to populate the stellar halo**, which hosts ancient stars disrupted during accretion events [Belokurov+18, Helmi+18]. Yet, **numerous VMP stars on disc-like orbits** were recently identified [Sestito+19,Fernández-Alvar+21,Nepal+24]!

In González Rivera de La Vernhe+24 [Paper I], we **confirmed** the existence of this peculiar population, using 36,000 VMP stars from the Pristine-*Gaia* synthetic (PGS) catalogue [Starkenburg+17,Martin+24].

Unfortunately, **kinematics alone are insufficient** to conclude whether VMP disc stars belong to a **thick disc or a halo component**. A thorough chemical analysis is required, but **few large-scale studies** are currently available.

Paper I

Spectroscopic study of 90 metal-poor giants

Observations: kinematical [1] + chemical [2] selection

- SOPHIE@OHP and ESPaDOnS@CFHT (66 stars): **reference thin and thick disc** + ***primitive* disc** stars (disc-like with lower [Fe/H]) selected with *Gaia* RVS
- UVES@VLT: 24 VMP **prograde-planar stars selected with PGS**

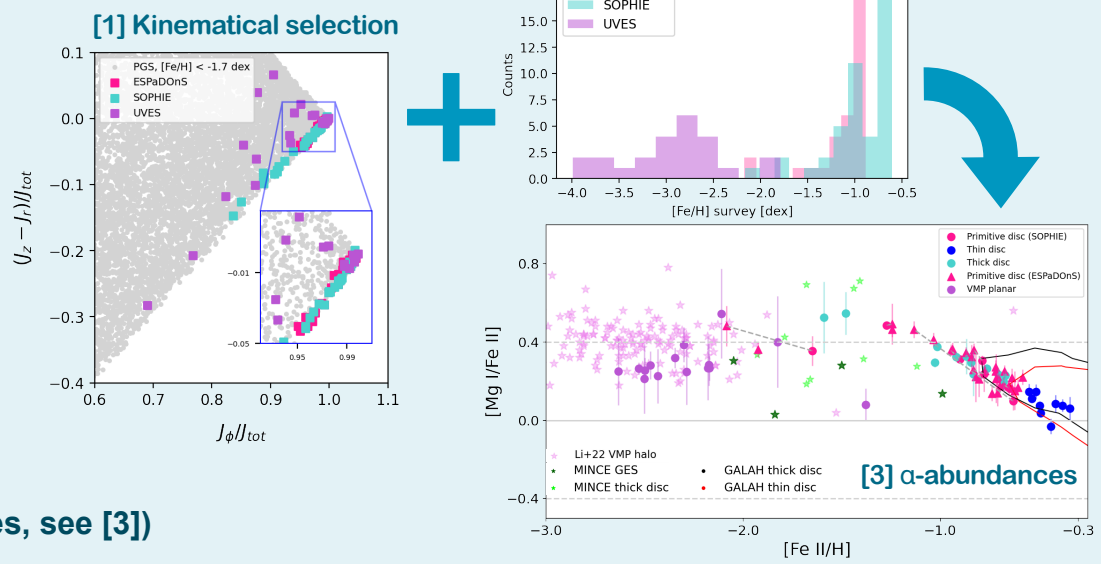
Methodology

- Spectral synthesis → photometry: isochrone projection [Kordopatis+23]
  → spectroscopy: pySME [Piskunov & Valenti 17]

⇒ **T_{eff}, log *g*, [M/H], v_{mic}, v_{mac}**

- LTE/NLTE abundance determination → pySME

⇒ **[Fe/H] and α-, neutron-capture, Fe-peak, odd-Z elements (20+ species, see [3])**



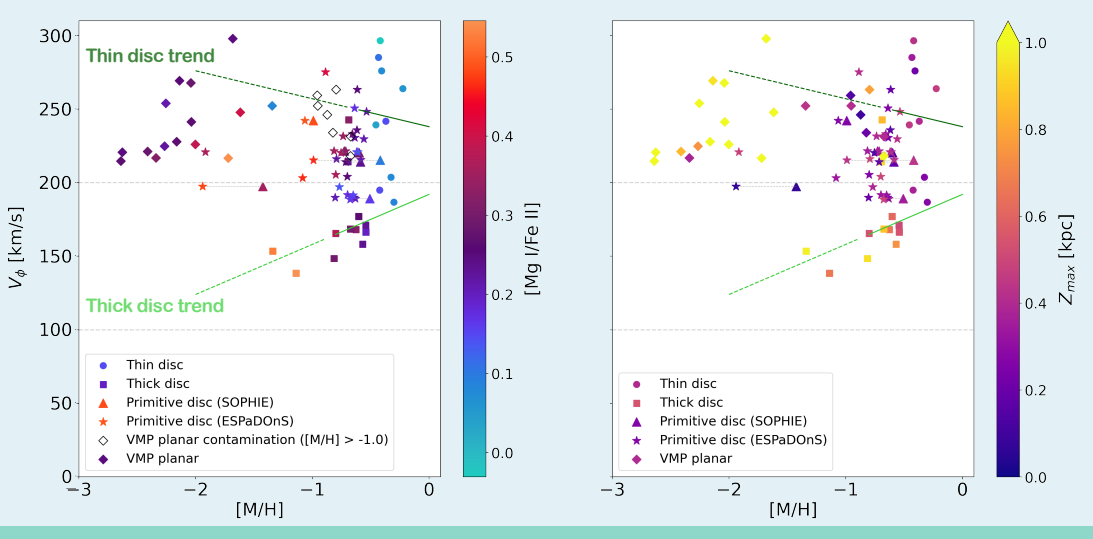
- Satisfying success rate for VMP disc selection in [Fe/H]: **70% with PGS!**
- Classical trends recovered for the thin/thick disc reference populations
- Primitive disc stars are **most chemically similar to a thick disc**
- VMP prograde-planar stars have lower **α-abundances: *ex situ* population?**

1) The metal-poor tail of the thin disc

- Comparison with theoretical thin and thick disc trends from [Kordopatis+17] (left panel, dark/light green lines): stars that best trace the thick disc have the lowest α, in contradiction with expected trends.
- VMP stars with the lowest vertical excursions (Z_{max} < 0.2 kpc, right panel) closely follow the theoretical thin disc V_ϕ trend.

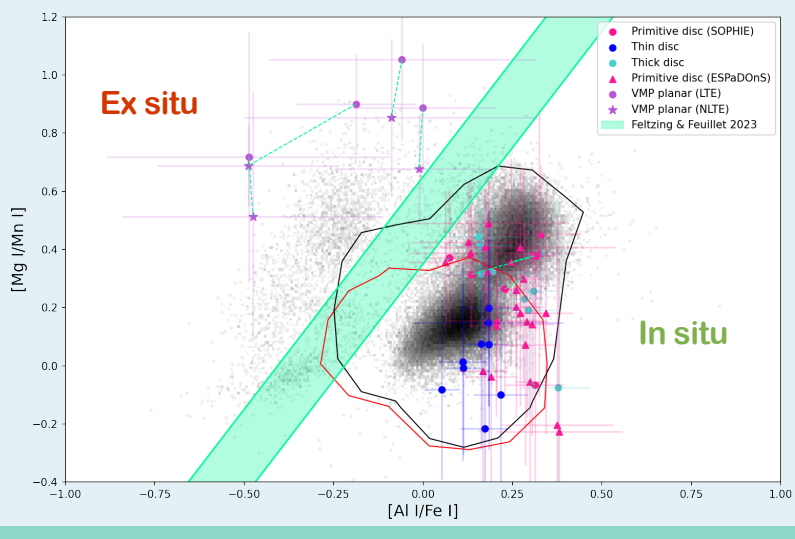
⇒ **The chemical signature of primitive disc stars is complex.**

⇒ **The disc may persist until [Fe/H] ~ -1 dex!**



2) The origin of the earliest disc stars

- [Mg/Mn]-[Al/Fe] diagram to highlight accreted stars [Hawkins+14]: reference thin/thick disc stars are located in the (expected) *in situ* area. **Primitive disc stars are also there, confirming their *in situ* nature.**
- VMP prograde-planar stars are located in the ***ex situ*** area.
- After making statistical comparisons of several Milky Way and dwarf galaxy populations using chemical abundances, the **true nature of *ex situ* stars remains difficult to understand.**



Stay tuned for González Rivera de La Vernhe+26 a & b, to be submitted!

Future work

As part of the PRIMA project, we will take advantage of the current synergy of observational techniques to effectively probe the **disc-halo interface** and shed light on the early disc. We aim to:

- Derive **accurate ages** using **asteroseismology** [Miglio+21]: PLATO
- Better interpret the oldest Galactic populations by accounting for he internal stellar structure/mechanisms and observational biases in **stellar population synthesis models** [BGM, Lagarde+17] and **stellar evolution models** [STAREVOL, Amard+19]

Acknowledgements

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