Echoes of the Underdogs: unveiling the origin of the earliest Galactic disc stars with observations and simulations

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The understanding of the Milky Way's assembly is crucial to probe the scenario of hierarchical galaxy formation on a large scale. Evidence supporting past accretion events can be observed in the form of substructures on the sky (e.g., stellar streams), or in the phase-space (e.g., the Gaia-Enceladus/Sausage merger), by studying the orbital and chemical properties of the most metal-poor stars ([Fe/H] < -2 dex).
Recently, several studies hinted at a population of metal-poor stars on disc-like orbits, i.e., planar and prograde with high angular momenta, pointing out the overall lack of consensus regarding the formation and potential origins of the Galactic disc. In González Rivera de La Vernhe et al. (2024), we highlighted the difficulty of relating this population to a halo or a disc component when solely relying on kinematics.
Using the Pristine-*Gaia* synthetic catalog of photometric metallicities, we select 24 giant stars with -3 < [Fe/H] < -2, to perform a high spectral resolution follow-up with UVES@VLT. After carefully deriving and validating stellar parameters for our sample, we investigate its chemical content in four main nucleosynthetic channels: α-process, neutron-capture, odd-Z, and Fe-peak, for a total of 25 chemical species. We then investigate the origin of the earliest disc stars in known chemical spaces, and compare our data with the trends of known *in* and *ex situ* populations from recent literature (e.g., GES, Loki, Sagittarius, bulge,...).
Our results highlight the need for improved modelling of the most metal-poor stars at both Galactic and stellar evolution scales, crucial to properly qualify the origin of the earliest disc-like stars and their ties to current disc and halo populations, shedding more light on the accretion history of the Milky Way. In the context of the PRIMA project (ANR-PRCI), efforts are currently underway to develop more realistic simulations tailored to these stars, combining the Galactic stellar population synthesis model of Besançon (BGM2.0) with stellar evolution models performed with STAREVOL. Preliminary results from these developments (e.g., using Pristine data), will be presented during this talk.