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Unravelling the chemical abundance patterns of the Milky Way building blocks

In the hierarchical mass assembly framework, the accretion history of the Milky Way (MW) is crucial to understand its evolution. Previous works have shown that the integrals of motion quantities (like energy and angular momentum) are not necessarily conserved when massive merger events are concerned, but rather they spread their stars throughout the dynamical spaces. Additionally, part of the in-situ disc component itself becomes kinematically heated and acquires halo-like orbits as a result of the merger. Consequently, even if minor mergers are supposed to preserve a higher degree of phase-space coherence - given the lower dynamical friction effect, we expect their kinematic-defined samples to be anyway contaminated by both the massive merger(s) and the thick disc stars, thus hiding different populations.
The main objective of this work is to quantify both these types of contamination within the accreted halo substructure known in literature mainly, by means of a chemistry-only analysis to uncover their specific chemical patterns.
We constructed the kinematic samples using Gaia EDR3 and APOGEE DR17 data. We adopted a Gaussian Mixture Model (GMM) approach, taking into account several chemical elements (Fe, Mg, Si, Ca, Mn, Al, C). This method incorporates the analysis of various abundances that probe different nucleosynthetic pathways, providing a percentage of global chemical compatibility. At the same time it allows to perform a comprehensive comparison between two samples of the overall trend of a given element [x/Fe] vs. [Fe/H]. In particular, it guards information about the eventual hidden different populations traced by the trend and potentially lost when computing averages.
We show that a number of halo substructures feature high fraction of chemically-compatible stars w.r.t. the most massive merger of the MW (i.e., Gaia Sausage-Enceladus), in a few cases pointing towards a shared origin or at least to a very similar chemical evolution history. Once their samples are cleaned from this contamination and from that due to the thick disc, we derive the specific chemical patterns of the known accreted halo substructures. This kind of approach will be vital for a more realistic reconstruction of the MW merger history in light of coming high-precision spectroscopic data.

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