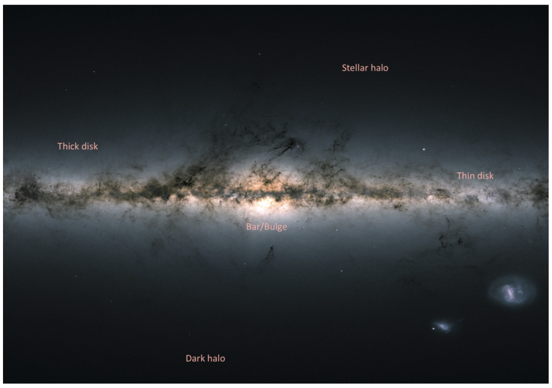
On the evolutionary history of the Milky Way and its building blocks



SUMMARY.

How galaxies form and evolve is one of the most important open questions in astronomy. There is evidence that galaxies are formed hierarchically, with low-mass galaxies merging over cosmic time and forming more massive systems. With the advent of large surveys such as Gaia and APOGEE, thousand of stars that were likely born in dwarf galaxies and later accreted to the Milky Way (MW) were found. However, the detailed mass assembly of the Milky Way as well as the evolutionary histories of its building blocks are still unknown. In this METEOR, we will explore the properties of a sample of stars which likely were accreted to the Milky Way in the past, deriving their chemical compositions and dynamical properties, in order to better understand the evolutionary history of the Milky Way and its building blocks.

OBJECTIVES

- **Knowledge**: The student will learn about how stellar atmospheric properties (e.g. effective temperature, surface gravity, metallicity and elemental abundances) affect the spectrum of a star, how to derive these properties from real stellar spectra obtained using one of the largest telescopes in the world (Clay Telescope at Las Campanas Observatory, Chile) and how these properties are used to understand the history of the Milky Way.
- **Skills**: The student will learn basics of stellar spectroscopic analysis, manipulation and analysis of large datasets, statistical methods and quality assessment of large datasets, and communication and collaboration within an international research group.

INSTITUTE

- Uppsala University, Uppsala, Sweden (Website).
- Box 256, SE-751 05 Uppsala, SWEDEN

THEORY

In this METEOR, the topics that will be covered will be:

- Optical stellar spectroscopy.
- Galactic chemical evolution.
- Milky Way assembly history.
- Large dataset statistical analysis.

APPLICATIONS

The student will work with a library of high-resolution spectra of over 150 metal-poor stars observed using the Mike Spectrograph at Clay Telescope at Las Campanas Observatory in Chile. These stars were chosen to represent the building blocks of the Milky Way. In this project, the student will develop relevant skills to execute Galactic Archaeology studies and also contribute to a detailed study on the dwarf galaxies that merged with the Milky Way in the past, connecting the chemical patterns of stars to the evolution of disrupted dwarf galaxies and the Milky Way's mass assembly history.

MAIN PROGRESSION STEPS

- Step 01: Learn how chemical abundances and dynamical properties of stars can unveil information about the evolution of the Milky Way and its building blocks.
- Step 02: Investigate a sample of metal-poor stars and understand their possible origins according to their orbital properties using Gaia survey data.
- Step 03: Learn how stellar atmospheric parameters and elemental abundances are calculated from stellar spectra.
- Step 04: Develop a pipeline to calculate stellar parameters and chemical abundances of a sample of metal-poor stars and analyze their findings in the context of Galactic Archaeology.
- Step 05: Document their findings, prepare a written report and give an oral presentation to be delivered to the Stellar Elemental Abundances group at the end of their stay.

EVALUATION

- Theory grade [30%]
  - Written report
- Practice grade [30%]
  - Participation in Stellar Elemental Abundances meetings (30%): which will include a presentation of their results.
  - Project (70%): initiative, progress, analysis.
- Defense grade [40%]
  - Oral and slides quality
  - Context
  - Project / Personal work
  - Answers to questions

BIBLIOGRAPHY & RESOURCES

- Freeman & Bland-Hawthorn., 2002, Annual Review of Astronomy and Astrophysics, v. 40, n. 1, p. 487-537.
- Helmi, 2020, Annual Review of Astronomy and Astrophysics, v. 58, n. 1, p. 205-256.

CONTACT

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