The chemical fingerprints of exoplanet-host stars

SUMMARY.

Understanding how planets form and evolve across our Galaxy requires uncovering the link between planets and their host stars. In this project, the student will explore this relationship by investigating how stellar parameters correlate with planetary properties such as mass, radius, multiplicity, and orbital characteristics. The student will gain experience in analyzing high-resolution stellar spectra using a variety of techniques, with a particular focus on determining the abundances of key chemical elements important for planet formation. The data used in this work are part of the scientific preparation for the Ariel space mission and will contribute directly to its goals.

OBJECTIVES

- **Knowledge**: understanding of stellar atmospheres via spectroscopy and the fundamental principles of the chemical evolution of our Galaxy
- **Skills**: hands-on analysis of high-resolution stellar spectra to derive stellar parameters and chemical abundances, statistical interpretation of planet-host star relations and Galactic stellar populations

INSTITUTE

The METEOR will take place at the Osservatorio Astrofisico di Arcetri part of the Istituto Nazionale di Astrofisica in Florence, Italy.

- INAF - Osservatorio Astrofisico di Arcetri
- www.arcetri.inaf.it
- Largo Enrico Fermi 5, I - 50125 Firenze, Italy

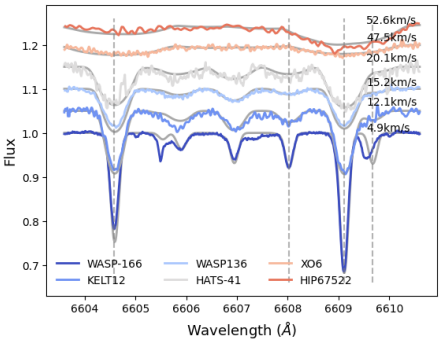
THEORY

by Maria Tsantaki, Camilla Danielski, Laura Magrini

During the METEOR stage, the student will learn the principles of line absorption mechanisms and how stellar atmospheric parameters (temperature, gravity, metallicity) affect the line strength. The properties of planetary systems as a population will be introduced, along with the key quantities that place constraints on models of planetary formation and migration, in particular those related to stellar chemical abundances. The key processes driving the chemical evolution of the Galaxy will be discussed, along with how chemical abundances change over time and across different regions of space.

APPLICATIONS

by Maria Tsantaki



Example spectra of planet-host stars analysed with the spectral synthesis technique from the Ariel mission candidate sample.

The student will analyze spectra of planet-host stars, with the goal of preparing the target list for the Ariel space mission, a mission dedicated to study the atmospheres of their planets. These spectra obtained from state-of-the-art spectrographs by our own observations and archival data will be analysed with specific analysis methods –such as the spectral synthesis with fasma– tailored to each spectral type. The student will first determine the atmospheric parameters, and then measure the abundances of key elements important for planet formation. These measurements will allow us to study correlations between stellar properties and the presence of planets. The student will use the theoretical knowledge of the chemical evolution of the Galaxy to infer its role in shaping planetary systems.

MAIN PROGRESSION STEPS

- `Tier 1`: Theory on stellar spectroscopy and star-planet relations
- `Tier 2`: Analysis of spectroscopic data
- `Tier 3`: Interpretation of the results

EVALUATION

- `Theory grade [20%]`
  - Presentation of an article (60%)
  - Participation in seminars (40%)
- `Practice grade [40%]`
  - Project (100%): initiative, performance
- `Defense grade [40%]`
  - Oral and slides quality
  - Knowledge of the scientific framework
  - Project / Personal work
  - Answers to questions

BIBLIOGRAPHY & RESOURCES

- Tsantaki et al., 2025
- da Silva et al., 2024
- Magrini et al., 2022
- `fasma`
- `Ariel stellar characterization`
- `Ariel space mission`

CONTACT

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