From Selection to Science: Assessing 4MOST's Observational Biases

SUMMARY.
Large surveys are fundamental to the advancement of astronomy and they have the potential to revolutionize our understanding of the Universe. In particular, the 4-metre Multi-Object Spectroscopic Telescope (4MOST) is a new survey currently in development that will observe many different classes of astronomical objects simultaneously, including stars and galaxies. Locally, 4MOST will measure the surface properties and compositions of tens of millions of stars across the Milky Way and nearby dwarf galaxies, helping us to understand the physical processes that shaped our Galaxy. However, in order to robustly interpret the data provided by 4MOST, we must understand how our target selection skews our results, as was done by previous stellar surveys (e.g. Stonkute et al. 2016, Wojno et al. 2017). In this METEOR, we will explore how different stellar properties are measured in 4MOST and how the selection and analysis of those stars can impact on our interpretation of the history of the Galaxy.

OBJECTIVES

- **Knowledge**: The student will learn about how stellar properties (e.g. effective temperature, surface gravity, metallicity and elemental abundances) affect the spectrum of a star, how they are measured in 4MOST, and how these properties are used to understand the history of the Milky Way. The student will also learn to work within a large, international collaboration and the details of generating and applying selection functions.
- **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 working 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.
- Selection functions in the context of Galactic Archaeology.
- Large dataset statistical analysis.

APPLICATIONS

The student will participate in activities related to the infrastructure working group in 4MOST focused on characterizing the survey's object selection function, which is used to evaluate bias in the survey related to stellar type and data quality. Multiple tests need to be performed to evaluate this selection function using the different spectral analysis pipelines employed. The student will assist in the execution and interpretation of these tests, while also learning the theoretical background of optical stellar spectroscopy and Galactic Archaeology. This METEOR project will therefore contribute to the overall characterization of 4MOST's selection function.

MAIN PROGRESSION STEPS

- `Step 01`: Learn how stellar atmospheric parameters and elemental abundances are calculated from stellar spectra.
- `Step 02`: Learn how the 4MOST data analysis pipelines work.
- `Step 03`: Execute tests and evaluate their results obtained from testing the 4MOST data pipelines on spectra of varying quality and stellar type.
- `Step 04`: Document their findings, prepare a written report and give an oral presentation to be delivered to the 4MOST working group at the end of their stay.

EVALUATION

- `Theory grade [30%]`
  - Written report
- `Practice grade [30%]`
  - Participation in 4MOST meetings (30%): which will include informal presentations of their results.
  - Project (70%): initiative, progress, analysis.
- `Defense grade [40%]`
  - Oral and slides quality
  - Context
  - Project / Personal work
  - Answers to questions

BIBLIOGRAPHY & RESOURCES

- 4MOST Webpage
- Stonkute et al., 2016, MNRAS, 460, 1131
- Wojno et al., 2017, MNRAS, 468, 3368

CONTACT

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