TESS observations of intermediate-mass stars

SUMMARY.
Intermediate-mass stars are fascinating objects: they spin rapidly, which flattens stars at the equator, induces internal mixing, and generally makes observations hard to interpret. They also often harbour oscillations, whose analysis is challenging but allows us to infer their parameters and open a window on their internal structure.
The stay will include lectures on stellar structure, evolution and oscillations, and training on frequency analysis tools. This will allow the student to analyze TESS observations for a sample of intermediate-mass pulsating stars at different rotation rates. Starting from luminosity variations measured from space, they will put together a strategy to extract oscillation frequencies accurately and derive stellar parameters for at least a few stars in the sample. By comparing their results with theoretical expectations, Gaia parameters, and other stars from the literature, they will asses the impact of rapid rotation and discuss sources of uncertainty.

OBJECTIVES

- The student will learn the evolution of stars, as well as strategies to characterize the parameters and structures of stars, with a focus on their rotation.
- The project consists in analyzing TESS data, extracting the frequencies of the oscillations propagating for stars in our sample, link oscillation properties with stellar parameters and compare these with Gaia estimates.

INSTITUTE

- Group of stellar evolution and nucleosynthesis
- Theoretical and Cosmos physics department, Universidad de Granada (Spain)
- Edificio Mecenas, campus de Fuentenueva, Granada, Spain

THEORY

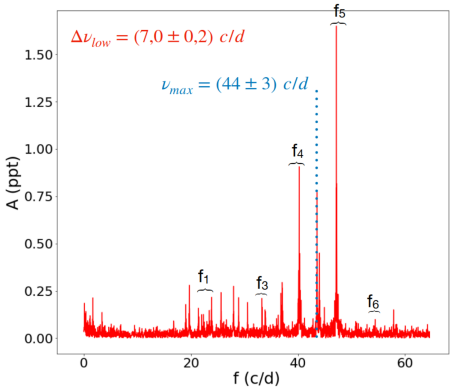
by G. Mirouh, A. García Hernández

This METEOR will complement the lectures in Nice by introducing advanced aspects of stellar physics, such as the impact of rotation on the stellar structure and evolution, and asteroseismology [1]. Data analysis techniques such as frequency extraction and pattern search will also be at the core of the lectures and project, with a tutorial for the Granada-developed tool MultiModes [2].

APPLICATIONS

by G. Mirouh, A. García Hernández

This METEOR consists in the study of a sample of intermediate-mass stars rotating at different speeds and observed by the TESS mission.
Frequencies will be extracted from photometric time series with MultiModes, the regular patterns they follow will be derived and related to stellar parameters through well-known scaling relations [3]. The parameters thus inferred will be compared with Gaia estimates, compared with similar targets, and used to assess the impact of rotation.
We expect the student to offer a modelling strategy, identify sources of uncertainties, and apply it to at least a few stars in the sample. Applications to more stars will obviously be valued positively.



Oscillation spectrum obtained using [2] for a TESS target, along with mode identification (in black) and seismic indicators (in red and blue).

MAIN PROGRESSION STEPS

- `Week 1-2`: Stellar physics and asteroseismology courses.
- `Week 3-4`: Frequency extraction techniques and exercices.
- `Weeks 5-9`: Project.

EVALUATION

- `Theory grade [30%]`
  - Written exam: stellar physics (50%)
  - Presentation of an article (50%)
- `Practice grade [30%]`
  - Practical exercice: frequency extraction and discussion (30%)
  - Project (70%)
- `Defense grade [40%]`
  - Oral and slides quality
  - Context
  - Project / Personal work
  - Answers to questions

BIBLIOGRAPHY & RESOURCES

- [1] Mirouh G. M., 2022, FrASS, 9, 2296
- [2] Pamos Ortega D. et al., 2022, MNRAS, 513, 374
- [3] García Hernández A. et al., 2015, ApJL, 811, 29

CONTACT

Giovanni M. Mirouh
☎ +34.613.009.508
✉ gmm@ugr.es