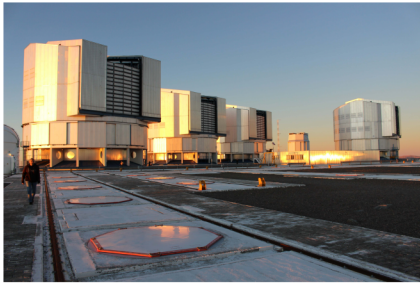




Stellar amplitude interferometry



The four Unitary Telescopes of the Very Large Telescope in the Desert of Atacama, Chile.

This course introduces students to amplitude stellar interferometry and to the main issues involved in meeting the requirements needed to achieve major advances in astrophysics with this technique.

Observing with a stellar interferometer provides access to high angular resolution. We will show how visibility measurements, derived from interferometric data, can be used to determine parameters related to the scientific targets as angular diameters or binary separations.

Because interferometric observable quantities are influenced by the Earth atmosphere and instrument's response, we will identify the main effects that impact the associated transfer function, the aim being to acquire the most stable and reliable sets of data possible.

The spectro-interferometer MATISSE, operating at the Very Large Telescope Observatory in the Atacama Desert in Chile, will serve as a central example throughout the course. The ultimate objective is to perform processing, calibration, and modelling of MATISSE data.

The courses consist of lectures presented on blackboard. Slide presentations will also be used to show relevant images and plots. The good understanding by the students of the addressed topics will be evaluated through their ability to solve analytical and numerical exercises. Laboratory works will also be conducted. Numerical work will be carried out using examples of data analysis from the MATISSE instrument. Active learning is mainly expected through in-class exercises, numerical modelling and simulation projects.

\$ make package

OBJECTIVES

- **Knowledge and understanding.** Students will learn the techniques of amplitude stellar interferometry, will apply diffraction theory to define the appropriate formalism, will learn the effects of the Earth atmosphere and of instrumental defects.
- **Applying knowledge.** Students will solve analytical exercises, run numerical simulations, conduct lab measurements, use MATISSE data to perform data calibration and modelling with such an instrument.

PREREQUISITES

- ✗ S1. Fourier Optics

THEORY

by SYLVIE ROBBE-DUBOIS

After a short historical overview and introduction, we will address the question of why a stellar interferometer is needed. The diffraction theory introduced in the Fourier Optics course will be used to define the intensity measured by an interferometer, as well as the degree of mutual coherence. Considering an interferometer as a spatial filter, we will show how to estimate the observable quantity, the squared visibility, which provides information about the source morphology.

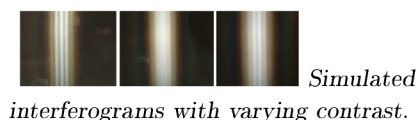
Factors that degrade the visibility will be studied, including terrestrial atmospheric turbulence and instrumental effects, leading to the error budget of the MATISSE instrument.

APPLICATIONS

by SYLVIE ROBBE-DUBOIS

Analytical exercises based on case studies will be proposed as direct applications of the course. Simulation exercises will also help for the preparation of the project. The labwork will help to understand the effect of the source morphology on the observable quantity, the squared visibility.

Concerning the project, two topics are offered, both related to data analysis from the MATISSE spectro-interferometer: model fitting of different types of sources (such as limb darkening, binary system, and star with envelope) based on visibility analysis; and the study of instrumental effects on the data, including residual effects from adaptive optics.



MAIN PROGRESSION STEPS

- 15h-20h: courses, analytical and numerical exercises

- 4h: labwork
- 15h-20h: project

EVALUATION

- **Written tests [20%]:**
Quiz-type: definitions and base calculus from lectures. Accuracy, relevance, completeness, conciseness.
- **Written lab report [20%]:**
Understanding, methodology, accuracy and relevance of the data collection, data analysis and interpretation of results.
- **Project [20%]**
Progress, analysis, initiative
- **Defense grade [40%]**
 - Oral and slides quality
 - Context
 - Project / Personal work
 - Answers to questions

BIBLIOGRAPHY & RESOURCES

- Millour F., New Astron.Rev. 52:177-185, (2008)
- Lopez B. et al., A&A, vol 659 (2022)

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