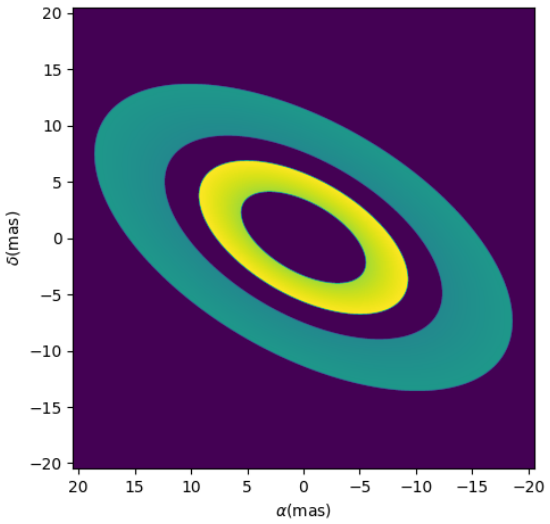
Modeling interferometric observations of protoplanetary disks



Schematic model image of a multi-ringed disk, generated with OIMODELER.

SUMMARY.
As of today, more than 5000 exoplanets have been discovered and show a great variety of characteristics (size, position). Understanding the origin of such variety requires direct observations of the protoplanetary disks around young stellar objects (YSOs), which require very high angular resolution and a relevant wavelength coverage. Combining 4 telescopes, the MATISSE instrument, on the VLTI, is able to probe the innermost regions (∼ 0.1-10 au) of protoplanetary disks, expected to be the birthplace of telluric planets. In this METEOR, we will review the basics of optical interferometry and see how MATISSE works. This will be complemented by a theoretical review on the physics of protoplanetary disks. We will then learn how to create and fit disk models to real MATISSE data on one selected protoplanetary disk, using the modelling tool OIMODELER. Physical parameters will be extracted from the modelling and discussed in the frame of the current knowledge of YSOs.

OBJECTIVES

- Understanding optical interferometry and its applications;
- Gaining knowledge on the basics of protoplanetary disk physics;
- Learning how to interpret real interferometric data;
- Running modeling code and fitting the data with it;

INSTITUTE

MPIA, Planet and Star Formation (PSF) department

- Max-Planck-Institut für Astronomie
- Königstuhl 17, D-69117 Heidelberg

THEORY

by Roy van Boekel

A first theoretical part will be dedicated to a review of the basics of interferometry followed by a description of the MATISSE instrument and its observables. Then, the student will be taught the basic physics of protoplanetary disks (emission mechanisms, evolution, mineralogy), in connection with the observational constraints that MATISSE can obtain on those objects.

MODELLING PRINCIPLES AND TOOLS

by Marten Scheuck

Here, the student will be taught the principles of modeling of interferometric observations and subsequent fitting to interferometric data. During this, they will be introduced to the modeling tool OIMODELER and its various functionalities.

APPLICATIONS

by Marten Scheuck & Roy van Boekel

The project will focus on the analysis and modelling of a set of MATISSE data already acquired by the consortium. The student will select an object to model based on data quality and completeness of the dataset. The student will start the model fitting of the MATISSE data with different types of models representing the circumstellar dust continuum emission using OIMODELER. In that context, the student will identify the best disk parameters to explore. After finding the best-fit solutions in terms of disk geometry and dust composition, he/she will provide an interpretation of the results in link with the existing literature and knowledge on the object.

MAIN PROGRESSION STEPS

- `Week 1`: Interferometry basics and MATISSE
- `Week 2`: Physics of protoplanetary disks
- `Week 3`: Principles of modeling + tutorial on OIMODELER
- `Week 4`: Selection of the object to model + bibliographic work
- `Weeks 5-8`: Modeling project
- `Weeks 9`: Oral exam + Oral presentation of the project results.

EVALUATION

- `Theory grade [30%]`
  The student will be evaluated on an oral presentation of an article. The article will be about the modelling of interferometric data obtained on a protoplanetary disk. The criteria of evaluation will be the understanding of the modelling approach and the data content, a critical view on the results and conclusions.
- `Practice grade [30%]`
  The grade will be based on the modelling project, following different criteria: selection of a relevant object, initiative, progress, critical analysis of the results, perspectives.
- `Defense grade [40%]`
  - Oral and slides quality
  - Context
  - Project / Personal work
  - Answers to questions

BIBLIOGRAPHY & RESOURCES

- MATISSE webpage
- MATISSE general article
- OIMODELER website

CONTACT

☎ +49 6221 528 405
✉ scheuck@mpia.de, boekel@mpia.de