



UNIVERSITAT_{DE}
BARCELONA

Master in Astrophysics, Particle Physics, and Cosmology

Academic year 2023-2024

Spring semester

Mon, Tue, Wed, Thur, 15:20 – 16:20
Room A33M

Stellar Formation and Structure

Presentation



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Stellar Formation and Structure

Gemma Busquet
Rosario López

Professors of the Department FQA

and

Invited Lectures

by active researchers in the field of star formation



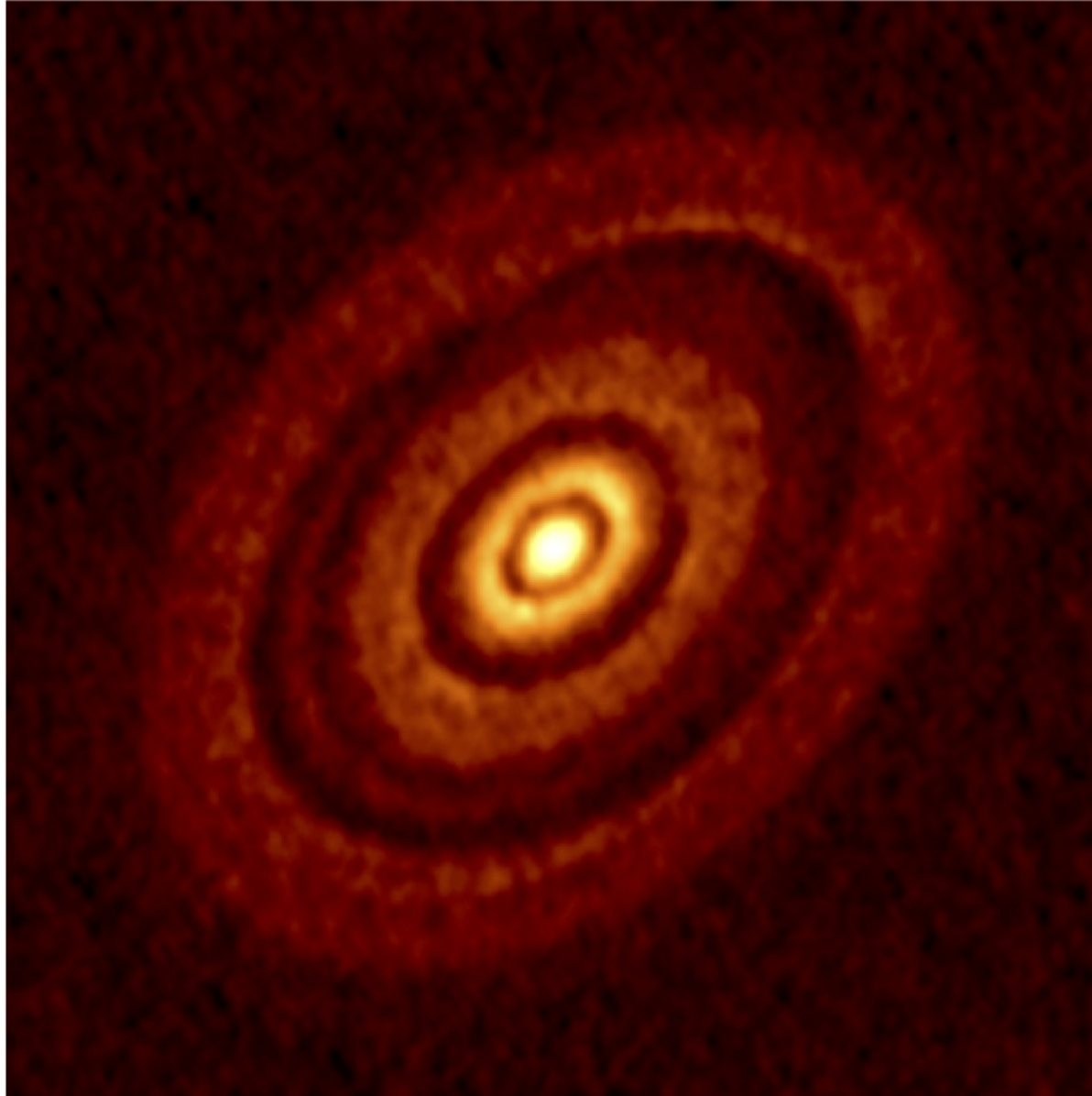
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The tools: radio telescopes

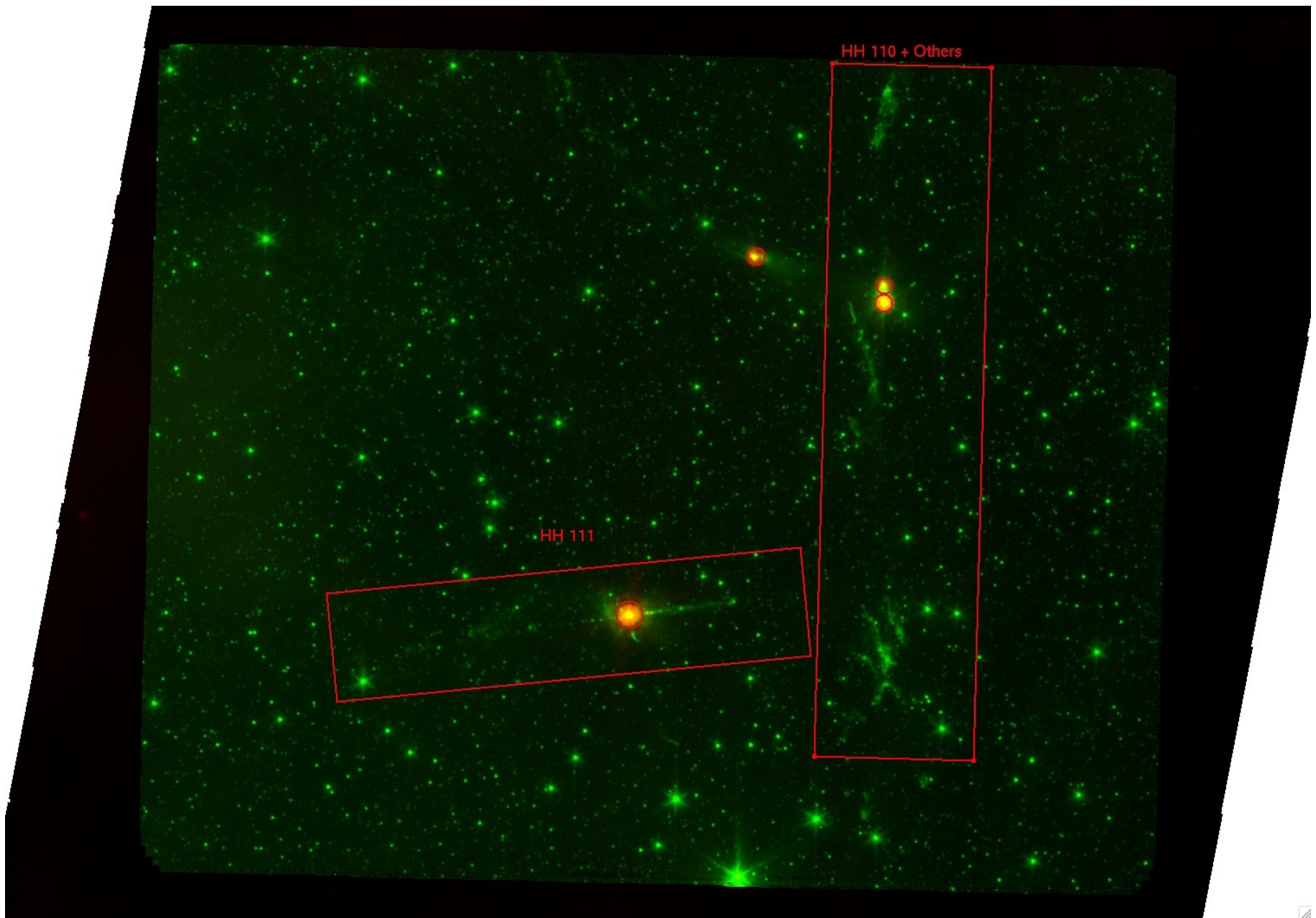




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ALMA image of the HL Tau protoplanetary disk
Credit: ALMA (ESO/NAOJ/NRAO)



HH111_HH110 at 4.5 + 24 μm from Spitzer



Program

1. Introduction

- The Milky Way Galaxy
- The Interstellar Medium

The tools: radio interferometry, optical and NIR astronomy

2. Interstellar medium and star-forming region

- **Interstellar dust.** Composition, physical properties. Extinction, reddening, polarization. Thermal emission, mass estimation
- **Atomic, ionized, and molecular gas.** Spectral line emission. Free-free emission and recombination lines of HII. Physical parameters from HII emission. Chemistry of the molecular gas, formation of molecules. Molecular lines, physical parameters from molecular line observations
- **Energy balance in molecular clouds.** Singular isothermal sphere, Bonnor-Ebert sphere, Jeans mass. Virial theorem. Turbulence, magnetic fields. Magnetically supported cores.
- **Molecular clouds.** Morphology, filaments, dense cores. Sites of star formation.



Program

3. Young Stellar Objects

- **Spectral Energy Distribution.** Classification of YSOs. Observational properties
- **PMS evolution.** Hayashi and Henyey tracks. ZAMS
- **TTauri stars, AeBe stars.** Models and observations
- **Interaction of YSOs with their environment.** Jets, Herbig-Haro objects, bipolar molecular outflows
- **Accretion and supersonic ejection processes** in YSOs. Accretion disks. Observation and models

Practical cases

**Basic concepts on
calibration and imaging
using CASA**



**Proposal
writing**





Invited Lectures

- **Maite Beltrán** (Osservatorio Astrofisico di Arcetri, INAF)
Protoplanetary disks around high-mass protostars
- **Álvaro Sánchez-Monge** (ICE-CSIC)
Formation of high-mass stars
- **João L. Yun** (U. Lisboa)
NIR observations

(2 more to be confirmed)



Work required to the students:

- Class attendance
- Small exercises to be presented during the course
- Discussion of a practical case elaborated from file data, applying observational techniques studied in the course
- Oral presentation on specific topics

40% of the final mark

- Final exam, consisting in questions on physical concepts, with a short answer

60% of the final mark



Lines of Research in the Star Formation Group

- High-angular resolution observations of the first stages of stellar evolution
- Outflows, jets, and accretion disks in low- and high-mass young stellar objects
- Computational models of star-forming clouds and star formation
- Interstellar-medium turbulence

Master Thesis Proposals

(https://icc.ub.edu/master_afpc/thesis/astro)

**Unveiling the nature
of the HH377 shock
through Herschel-
PACS observations**

Advisors: Rosario López &
Gemma Busquet

**Developing line
identification
algorithms in the era
of Large Surveys**

Advisors: Gemma Busquet

**Grain growth and
chemical
composition in
G14.225-0.506**

Advisors: Gemma Busquet

**Non-thermal emitters
in Orion A**

Advisors: Valentí Bosch-
Ramon & Gemma Busquet

In collaboration with the
High Energy Astrophysics Group