

## Theoretical and Numerical Astrophysics (C004505)

**Course size** *(nominal values; actual values may depend on programme)*

**Credits 6.0**

**Study time 180 h**

**Course offerings in academic year 2025-2026**

A (semester 1)

English

Gent

**Lecturers in academic year 2025-2026**

Baes, Maarten

WE05

lecturer-in-charge

**Offered in the following programmes in 2025-2026**

[Master of Science in Teaching in Science and Technology\(main subject Physics and Astronomy\)](#)

[Master of Science in Physics and Astronomy](#)

[Master of Science in Physics and Astronomy](#)

[Exchange Programme in Physics and Astronomy \(Master's Level\)](#)

**crdts**

**offering**

6

A

6

A

6

A

6

A

**Teaching languages**

English

**Keywords**

Astrophysics, stellar dynamics, galaxy formation and evolution, gravity, hydrodynamics

**Position of the course**

Galaxies are extremely complex objects and understanding their formation and evolution is one of the main challenges in modern astrophysics. Students starting the MSc in Physics and Astronomy should have a solid understanding of the structure and the different components of galaxies and their position in the large-scale structure of the Universe. The main goals of the present course are (1) providing a thorough theoretical treatment of fundamental aspects that shape galaxies throughout their cosmic evolution, and (2) exploring the numerical methods used by astrophysicists to study galaxy evolution in a cosmological context.

**Contents**

- 1 Gravity: stellar dynamics
- 2 Gravity: systems of particles
- 3 Astrophysical hydrodynamics

**Initial competences**

Successful completion of the BSc courses Galaxies (C004214) and Structure of the Universe (C004221) or having acquired the necessary competences in another way. Students are assumed to have a good working knowledge of Python, at the level acquired in the BSc course Python for Scientists (C004212).

**Final competences**

- 1 Understand potential theory and the theory of stellar dynamics.
- 2 Derive the different numerical schemes that are at the basis of astrophysical N-body and hydrodynamic simulations.
- 3 Understand the advantages and disadvantages of the different simulation techniques for specified astrophysical problems.
- 4 Explain the structure, dynamics and evolution of dark matter haloes and galaxies
- 5 Understand the fundamental ingredients at work in galaxy evolution and link their effect of observational properties.

**Conditions for credit contract**

Access to this course unit via a credit contract is determined after successful competences assessment

**Conditions for exam contract**

This course unit cannot be taken via an exam contract

**Teaching methods**

Seminar, Lecture

**Extra information on the teaching methods**

The theory is thoroughly explained during the lectures. The exercises are in the form of supervised Python exercises.

**Study material**

Type: Syllabus

Name: Syllabus TANA

Indicative price: € 15

Optional: no

Language : English

Number of Pages : 300

Oldest Usable Edition : 2025-2026

Available on Ufora : No

Online Available : No

Available in the Library : No

Available through Student Association : No

Type: Slides

Name: Slides TANA

Indicative price: Free or paid by faculty

Optional: no

Language : English

Number of Slides : 1000

Available on Ufora : Yes

Online Available : Yes

Available in the Library : No

Available through Student Association : No

**References**

- Cimatti et al. (2019), Introduction to Galaxy Formation and Evolution: From Primordial Gas to Present-Day Galaxies (ISBN 1107134765)
- Bodenheimer et al. (2006), Numerical methods in Astrophysics, An Introduction (ISBN 0750308834)
- Binney & Tremaine (2010), Galaxy Dynamics (ISBN 1400828724)

**Course content-related study coaching**

The material is thoroughly explained during the lectures. The lecturer and teaching assistant(s) are available for additional coaching.

**Assessment moments**

end-of-term and continuous assessment

**Examination methods in case of periodic assessment during the first examination period**

Written assessment with open-ended questions, Assignment

**Examination methods in case of periodic assessment during the second examination period**

Written assessment with open-ended questions

**Examination methods in case of permanent assessment**

Assignment

**Possibilities of retake in case of permanent assessment**

examination during the second examination period is possible

**Calculation of the examination mark**

Theory: 50%

Exercise exam: 25%

Programming project(s): 25%

**Facilities for Working Students**

All the presentations are available online for students that cannot attend the classes, and the lecturers are available for additional explanations.