GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2017-2018

Astrophysical Simulations (C002329)

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

Credits	6.0	Study time	180 h
Contact hrs	52.5 h		

Course offerings and teaching methods in academic year 2018-2019

A (semester 1)	Dutch	lecture	30.0 h
		project	15.0 h
		seminar: practical PC room classes	7.5 h

Lecturers in academic year 2018-2019

Baes, Maarten	WE05	lecturer-in-charge

Offered in the following programmes in 2018-2019	crdts	offering
Master of Science in Physics and Astronomy	6	A
Master of Science in Mathematics	6	A

Teaching languages

Dutch

Keywords

Astrophysics, modelling and simulating, gravitational N-body problem, hydrodynamics

Position of the course

Astronomical observations show that most astrophysical structures are remarkably complex at all scales. To understand how such structures form and evolve, astronomers need to adopt numerical simulations that take into account general physical processes such as gravity and hydrodynamics. The goal of this course is, starting from the fundamental physical equations, to introduce the most common simulation techniques and describe their basic concepts, possibilities and constraints.

Contents

- Introduction
- The gravitational N-body problem
- Softening and regularisation in the N-body problem
- Force calculation in N-body simulations
- State-of-the-art N-body simulations
- Astrophysical hydrodynamics
- Grid-based hydrodynamics
- Smoothed particle hydrodynamics
- Moving mesh hydrodynamics
- State-of-the-art hydrodynamics simulations

Initial competences

Introduction to astronomy (C003016)
Extragalactic astronomy (C002994)

Final competences

1 Derive the fundamental equations for gravitational N-body problems and hydrodynamics
2 Starting from the fundamental equations, derive the different numerical schemes that are at the basis of astrophysical simulations.
3 Understand the advantages and disadvantages of the different simulation techniques for specified astrophysical problems.
4 Explain the structure and evolution of astrophysical systems such as star clusters and galaxies, based on numerical simulations.

5 Simulate simple astrophysical problems in the framework of a programming project, individually or in small group.
6 Summarize the results of a programming project and present them in an oral presentation.

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

Lecture, project, seminar: practical PC room classes

Extra information on the teaching methods

Exercises: in small groups in the computer room

Learning materials and price

English syllabus
Estimated price: 10 EUR

References

- Numerical methods in Astrophysics, An Introduction - ISBN 0750308834
- The Physics of Astrophysics – Volume I: Radiation - ISBN 0935702644
- The Physics of Astrophysics – Volume II: Gas Dynamics - ISBN 0935702652
- Astrophysical Hydrodynamics: An Introduction - ISBN 3527406697

Course content-related study coaching

The material is thoroughly explained during the lectures. The students are guided extensively for the computer exercises and the programming project. The lecturer and teaching assistent(s) are available for additional coaching.

Evaluation methods

end-of-term evaluation and continuous assessment

Examination methods in case of periodic evaluation during the first examination period

Written examination with open questions

Examination methods in case of periodic evaluation during the second examination period

Written examination with open questions

Examination methods in case of permanent evaluation

Oral examination, assignment, peer assessment

Possibilities of retake in case of permanent evaluation

examination during the second examination period is not possible

Extra information on the examination methods

The periodic exam is a written exam in which the student's knowledge of the theory is tested. This exam counts for 50% of the final grade.
The non-periodic part of the exam consists of a programming project that is linked to one of the subjects handled in the course. The students make this programming project in groups composed by the lecturer. A fraction of the grade is awarded through peer assessment, the remainder is awarded by the lecturer based on the code and an oral presentation. This programming project can only be submitted in the first examination period; for students that fail for the course in the first examination period and participate in the second examination period, the grade from the first period is automatically transferred.

Calculation of the examination mark

Theory: 50%
Programming project: 50%