

Statistical Physics 1 (C002461)

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

Credits 6.0

Study time 180 h

Contact hrs

52.5h

Course offerings and teaching methods in academic year 2022-2023

A (semester 1)

Dutch

Gent

lecture

30.0h

online seminar: coached

0.0h

exercises

seminar: coached exercises

22.5h

online lecture

0.0h

Lecturers in academic year 2022-2023

Ryckebusch, Jan

WE05

lecturer-in-charge

Offered in the following programmes in 2022-2023

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

crdts

6

offering

A

Teaching languages

Dutch

Keywords

Statistical physics, physics of classical and quantum systems with many degrees-of-freedom

Position of the course

This course is part of the learning line *theoretical physics* in the BSc program physics and astronomy. It aims at providing a formal development of the techniques adopted in statistical physics. In a next step, these techniques are applied to outline the statistical physics of interacting - and non-interacting systems, of quantum-mechanical phenomena at extremely low temperatures and the theory of critical phenomena (phase transitions). A profound knowledge of statistical physics is a prerequisite for studying astrophysics, condensed-matter physics and subatomic physics. One of the major objectives of the course is establishing the link between statistical physics and numerical simulation techniques.

Contents

- First, second and third law of thermodynamics
- The canonical system (fluctuations and response functions, paramagnets, negative temperatures, defects in solids, systems of coupled and uncoupled harmonic oscillators, ensemble theory, introduction to information theory, Liouville's theorem, phase space)
- Classical systems (ideal gases, real gases, cluster expansions, theory of liquids, molecular-dynamics technique)
- Quantum statistics (relation between spin and statistics, ideal quantum gas, ideal photon gas, density matrix)
- The grand-canonical system and the Gibbs partition function (chemical potential, grand-canonical partition function)
- The ideal Fermi gas (equation of state, ideal Fermi gas, white dwarfs, Pauli paramagnetism)
- The ideal Bose gas (equation of state, superfluidity, Bose-Einstein condensation, low-temperature physics)
- Critical phenomena (Ising system, order parameters, mean-field theory, Landau-Ginzburg theory, computer simulations, correlation functions, universality,

Monte-Carlo techniques)

Initial competences

The development of the theory of statistical physics relies on concepts of Newtonian mechanics and quantum mechanics. A good working knowledge of thermal physics (at the level of an introductory course in thermodynamics), analysis, and algebra is essential.

Final competences

- 1 Master the basic techniques adopted in statistical physics for describing the physics of systems consisting of many degrees of freedom.
- 2 Acquaint the student with modelling and simulation techniques, as a powerful tool to learn about systems with many degrees-of-freedom.
- 3 To acquire insight into the link between the microscopic and macroscopic world.

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

Online discussion group, Online lecture, Lecture, Online seminar: coached exercises, Seminar: coached exercises

Extra information on the teaching methods

Theory : lectures with frequent use of computer simulations.

Problem sessions : small groups. The students communicate their solutions to the group.

Learning materials and price

Course material is made available through the electronic learning system of the university.

References

F. Mandl "Statistical Physics" (John Wiley & Sons, 1998)

Ralph Baierlain "Thermal Physics" (Cambridge University Press, 1999)

Kerson Huang "Statistical Mechanics" (John Wiley & Sons, 1987)

Franz Schwabl "Statistical Mechanics" (Springer, Berlin, 2002)

Course content-related study coaching

The lecturer offers the possibility to discuss the course material with small groups of students. The electronic learning-environment is employed to discuss the course material with the students and to draw their attention to recent advances in statistical physics.

Assessment moments

end-of-term assessment

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

Open book examination, Written examination with open questions

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

Open book examination, Written examination with open questions

Examination methods in case of permanent assessment

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

Theory : written exam

Problems : written exam (use of the course material is allowed)

Calculation of the examination mark

- 40% for the open-book part of the written exam
- 60% for the closed-book part of the written exam

