

Field Theory for Statistical Mechanics (C004518)

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

Credits 6.0

Study time 180 h

Course offerings in academic year 2026-2027

null

Lecturers in academic year 2026-2027

Bultinck, Nick

WE05

lecturer-in-charge

Offered in the following programmes in 2026-2027

null

crdts

offering

Teaching languages

English

Keywords

Statistical physics, field theory, renormalization

Position of the course

Contents

- 1 **Statistical physics and field theory:** Lightening review of the necessary concepts from statistical physics. Path integrals and quantum field theory. The quantum-classical mapping. Universality of long-distance properties and effective field theories. Basic philosophy behind renormalization and the connection to critical exponents.
- 2 **Momentum-shell renormalization:** Perturbative calculation of the Wilson-Fisher RG fixed point and the critical exponents via the epsilon expansion. The $O(N)$ model as an effective field theory for magnetism, and the calculation of the beta function in two dimensions.
- 3 **2D XY model:** Villain representation of the partition function. The sine-Gordon continuum field theory description. The Berezinskii-Kosterlitz-Thouless phase transition and the Kosterlitz renormalization group analysis.
- 4 **3D XY model:** Particle-vortex duality and the dual $U(1)$ gauge theory description.
- 5 **3D compact electrodynamics:** The role of magnetic monopoles for confinement in $U(1)$ gauge theory on the lattice.

Initial competences

Statistical mechanics, quantum mechanics, quantum field theory

Final competences

- 1 The student has an understanding of the universality of statistical physics on large length scales, and how this allows for a continuum field theory description.
- 2 The student can perform calculations in continuum field theory, and is able to use these to derive physical 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

Study material

Type: Syllabus

Name: Field theory for statistical mechanics

Indicative price: Free or paid by faculty

Optional: no

References**Course content-related study coaching****Assessment moments**

end-of-term assessment

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

Oral assessment

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

Oral assessment

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

not applicable

Calculation of the examination mark