FSI3330 Thermal Field Theory 7.5 credits

Termisk fältteori

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for FSI3330 valid from Spring 2019

Grading scale

P, F

Education cycle

Third cycle

Specific prerequisites

The course is mainly intended to graduate students with interest in theoretical physics and cosmology. Basic knowledge in statistical mechanics and quantum field theory are prerequesites.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

Upon passing the course the student should:

- Be able to recount how a finite temperature and density background affects field theoretical computations.
- Treat bosonic and fermionic systems and quantization within thermal field theory.
- Be able to use thermal field theory to describe spontaneous symmetry breaking at finite temperature.

Course contents

Part I:

- Introduction. General concepts of statistical physics and quantum field theory
- Quantization of the bosonic field at finite temperature; Matsubara frequencies; Feynman rules at finite temperature
- Quantization of the fermionic field at finite temperature; fermionic path integrals and coherent state formalism
- Quantization of the gauge fields at finite temperature; ghosts and blackbody radiation; static screening
- Renormalization and infrared problems
- Collective excitations in a plasma
- Equivalence of real-time and imaginary-time formalism

Part II:

- Linear response theory
- Resummation and effective actions; Daisy diagrams
- Hard thermal loop expansion
- Dynamical screening

Part III:

- Spontaneous symmetry breaking and restoration
- Phase transitions and inflation
- Transport equations and baryogenesis; Kadanoff-Baym equations in Wigner space

Disposition

Lecture I: Introduction. Canonical ensembles in statistical physics. Path integral formulation of quantum mechanics.

Lecture II: Imaginary time formalism of bosonic systems.

Supplement I: Regulariziation and renormalization in QFT.

Lecture III: Real time formalism of bosonic systems.

Lecture IV: Fermionic systems in TFT.

Lecture V: Quantization of gauge fields in QFT and TFT.

Lecture VI: Seminars.

Lecture VII: Spontaneous symmetry breaking at finite temperature. Seminar.

Supplement II: Non-abelian gauge fields.

Lecture VIII: Seminar.

Lecture IX: Seminar. Quantum Boltzmann equations from the real time formalism.

Discussion of the problem set.

Course literature

- M. Le Bellac, **Thermal field theory**, Cambridge University Press, 1996
- J. I. Kapusta, **Finite-temperature field theory**, Cambridge University Press, 1989

Examination

- INL1 - Assignment, 7.5 credits, grading scale: P, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

Hand in assignments.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.