Module:

Elective Advanced Lectures: Theoretical Physics

Module No.: physics70c





Quantum Field Theory for Condensed Matter Physics (T)

Course No.: physics759a

Category	Туре	Language	Teaching hours	СР	Semester
Elective	Lecture with exercises	English	3+2	7	WT

Requirements for Participation:

Quantum Mechanics (physik421) Thermodynamics and Statistical Physics (physik521)

Preparation:

Elementary condensed matter physics (physik411 or similar)

Form of Testing and Examination:

Requirements for the examination (written or oral): successful work with the exercises

Length of Course:

1 semester

Aims of the Course:

Knowledge of quantum field theory of interacting many-body systems at finite temperature Knowledge of quantum field theory for non-equilibrium systems Ability to construct and evaluate perturbation theory using Feynman diagrams Basic understanding of problems of open quantum systems

Contents of the Course:

Fock space and occupation-number representation for bosons and fermions (if not yet familiar) Elementary linear response theory

Quantum field theory at finite temperature: functional integral fomulation

Green's functions: analytical properties and their relation to observable quantities

Perturbation theory in thermodynamic equilibrium: Feynman diagrams, Matsubara technique Kondo effect and renormalization group

Quantum field theory away from thermodynamic equilibrium: Schwinger-Keldysh functional integral Perturbation theory away from equilibrium: Keldysh technique

Open and driven-dissipative quantum systems: Lindblad formalism

Recommended Literature:

 A. Kamenev, Field Theory of Non-Equilibrium Systems, 2nd edition, Cambridge University Press (2023).
G. Stefanucci, R. van Leeuwen, Nonequilibrium Many-Body Theory of Quantum Systems, A Modern Introduction, Cambridge University Press (2013).

H.-P. Breuer, F. Petruccione, The Theory of Open Quantum Systems, Oxford University Press (2002, reprinted 2010).

P. Coleman, Introduction to Many-Body Physics, Cambridge University Press (2015, reprinted 2017).