

Module: Elective Advanced Lectures: Theoretical Physics

Module No.: physics70c

Course:  universität**bonn**

Quantum Field Theory for Condensed Matter Physics (T)

Course No.: physics759a

| Category | Type | Language | Teaching hours | CP | 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 formulation

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).