Theoretical Condensed Matter Physics: Physics of Strong Correlations in Metals

Instructor: H. Kroha

Lectures: Tue 10:15 - 12:00, Thu 12:15 - 13:00 at lecture hall IAP

Exercises: Wed 15:15 - 17:00 at AVZ 118 (with P. Henseler)
(exception: Wed, 26.10. 16:15 - 18:00 at AVZ 118)

Certificates: Ungraded certificates will be assigned for attaining 50% of all possible homework points. For a graded certificate an oral exam at the end of the term is necessary.

Prerequisites: Nonrelativistic quantum mechanics including 2nd quantization and elementary statistical physics

General description: The lecture course presents an introduction to the modern theory of solids. Special emphasis will be put on a balanced introduction to both the relevant theoretical methods and to the phenomena important for contemporary research.
Although the course will introduce the students to some of the present research topics, a basic background knowledge of the topics given above will be sufficient to follow the course

Contents:

- Elementary band structure theory of periodic solids
- Quantum field theory of many-particle systems at finite temperature
- Introduction to quantum field theory away from thermodynamic equilibrium (Keldysh technique)
- Theory of normal Fermi liquids
- Collective excitations of the crystal lattice: phonons
- Collective excitations of the electron system: plasmons etc.
- Instabilities of the Fermi liquid:
  a) Superconductivity (BCS theory)
  b) Charge density instability (Peierls instability)
- Defects in crystals and their consequences for the electron system (disordered solids)

Literature:

- N. W. Ashcroft, N. D. Mermin: Solid State Physics
- W. Jones, N. H. March: Theoretical Solid State Physics (Vol. 1 & 2)
- A. A. Abrikosov: Fundamentals of the Theory of Metals
- P. M. Chaikin, T. C. Lubensky: Principles of condensed matter physics
- Ch. Kittel: Quantum Theory of Solids
- Ch. Kittel: Introduction to Solid State Physics
- W. Nolting: Grundkurs Theoretische Physik 7: Viel-Teilchen-Theorie
- L. D. Landau, E. M. Lifshitz: Statistical Physics II (Course of Theoretical Physics Vol. 9)
- A. A. Abrikosov, L. P. Gorkov, L. E. Dzyaloshinsky: Methods of Quantum Field Theory in Statistical Physics
- G. Mahan: Many Particle Physics
- M. Tinkham: Introduction to Superconductivity
- J. R. Schrieffer: Theory of Superconducivity
- G. Grüner: Density Waves in Solids
- S. Doniach, E. H. Sondheimer: Green's Functions for Solid State Physicists
- D. Pines: The Many-Body Problem
- G. Rickayzen: Green‘s Functions and Condensed Matter
- A. M. Zagoskin: Quantum Theory of Many-Body Systems : Techniques and Applications
- X. G. Wen: Quantum Field Theory of Many-Body Systems