

WINTER 2023/4

## CONDENSED MATTER THEORY

- 1. Microscopic description of many-body systems and effective models
- 2. Phonons
- 2.1 Second Quantisation
- 2.2 Interaction between phonons and neutrons
- 2.3 Lifetime of phonons
- 2.4 Mößbauer effect
- 3. Electrons in condensed matter systems
- 3.1 Second Quantisation for fermions
- 3.2 Independent electron models
- 3.3 (Semi-)classical transport
- 3.4 Conductance quantisation
- 3.5 Disorder and localisation
- 4. Topological invariants
- 4.1 The geometry of Hilbert space and the Berry phase
- 4.2 Berry curvature of Bloch bands
- 4.3 Change of band topology and chiral edge modes
- 4.4 Quantum Hall effect without Landau levels
- 4.5 Topological insulators

- 5. Interacting electrons
- 5.1 The single particle Green's function
- 5.2 Hartree-Fock approximation
- 5.3 Correlation energy
- 5.4 Screening in one-particle approximation
- 5.5 Dielectric response and structure function
- 5.6 Fermi liquid theory
- 5.7 Instabilities of Fermi liquids
- 6. Superconductivity
- 6.1 Electron-phonon coupling
- 6.2 Cooper-pairs
- 6.3 The superconducting ground state
- 6.4 Excited states
- 6.5 BCS at finite temperatures

## LITERATURE:

Abrikosov, Gorkov, Dzyaloshinski: Methods of Quantum Field Theory in Statistical Physics

Altland, Simons: Condensed Matter Field Theory

Anderson: Concepts in Solids

Girvin, Yang: Modern Condensed Matter Physics

Kittel: Quantum Theory of Solids

Sólyom, Fundamentals of the Physics of Solids I-III