

Superconductivity: Beyond the weak-coupling theory of Bardeen, Cooper, and Schrieffer (master thesis - V. Janiš, janis@fzu.cz)

- Superconductor — fundamental features
 - Non-dissipative electric current (no Joule heat)
 - Expels magnetic field (Meissner effect)
- Existing theory
 - Bardeen, Cooper, Schrieffer (BCS) - weak-coupling (static) mean field
 - Coherent state of bound electron, spin singlet pairs (Cooper pairs)
- **Problems to address:**
 - Extension of mean-field theory to strong coupling — transition from BCS state to Bose-Einstein condensate
 - Dynamical and magnetic excitations of the superconductor
- **Methods of solution:**
 - Model of electrons with attractive interaction
 - Many-body perturbation theory with Feynman diagrams
 - Green functions in the Nambu (spinor) formalism
- **Prerequisites:**
 - Quantum mechanics
 - Statistical mechanics
 - Analysis of complex variable