Condensed matter theory

Spring semester 2012/2013

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Course program:

1. Introduction
   - 1.1 Electrons in metals: methods and approximations.
   - 1.2 Non-interacting fermions: specific heat, electrical and thermal conductivities, Wiedemann–Franz law.
2. Symmetries of electronic states in crystals.
   - 2.1 Groups and their representations.
   - 2.2 Crystal symmetries and degeneracies of energy bands.
3. Electron-electron interactions.
   - 3.1 Second quantization, introduction to diagrammatic methods.
   - 3.2 Hartree-Fock approximation.
   - 3.3 Random-phase approximation and screening of Coulomb interactions.
   - 3.4 Landau Fermi liquid theory.
   - 3.5 Numerical approaches: density functional theory, local density approximation.
4. Electron-phonon interactions.
   - 4.1 Phonons. Specific heat of phonons.
   - 4.2 Resistivity due to phonons.
   - 4.3 Attraction between electrons mediated by phonons.
5. BCS theory of superconductivity.
   - 5.1 BCS Hamiltonian and mean-field approximation.
   - 5.2 BCS ground state, Cooper pairs, quasiparticles.
   - 5.3 Relation between the transition temperature and the zero-temperature gap.

Literature:

Recommended books:

[AM] N. W. Ashcroft and N. D. Mermin, Solid State Physics.

[Mar] M. P. Marder, Condensed Matter Physics.

Useful lecture notes:

[AS] Andreas Schilling, lecture notes 2010/2011.

Organizational details:

- 12 lectures and 12 exercise sessions (12 problem sets)
- Final exam: oral
- Requirement: completed 8 out 12 problem sets
- Course web page (lecture notes, problem sets, etc.): `http://www.physik.uzh.ch/lectures/th-pkm/`
- My e-mail: `ivanov@phys.ethz.ch`