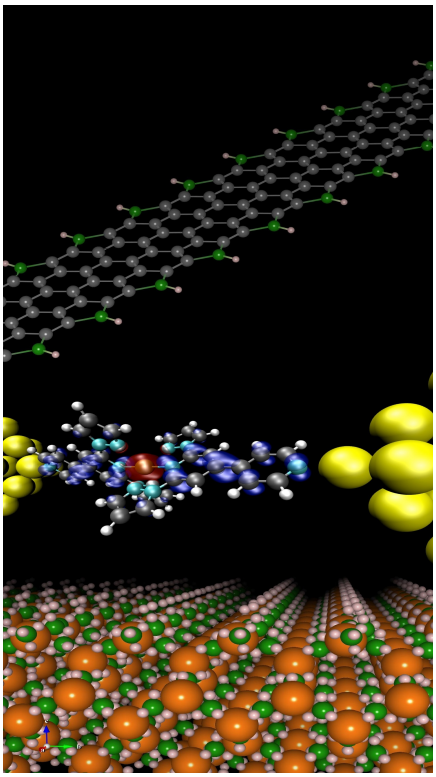
Institut für Theorie der Kondensierten Materie
Institut für Nanotechnologie

Karlsruhe Institute of Technology

Lecture announcement WS 2011/2012

Computational Condensed Matter Theory



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Lecture: Do 9:45-11:15.
Practice: block exercises, (SWS: 2+1)
Kl. HS B, KIT, Campus South.

Requirements:

Lecture: basic quantum mechanics & solid state physics
Practice: basics programming knowledge
Literature: will be given in first lecture course

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The advent of powerful numerical algorithms -- like the transfer-matrix method, numerical renormalization group schemes, Krylov-subspace methods, ...-- together with the improving computer power has opened up a completely new route to test existing ideas and of course also to obtain entirely new physical insights. Nowadays, numerical calculations and simulations provide a well established tools in all branches of theoretical physics. In fact, in some cases they even provide the only route for systematic studies and improved understanding.

This lecture offers an introduction into the basic techniques of computational physics and the conceptual ideas behind it. The pedagogical approach will be to start from a fundamental physical problem and to develop a numerical approach from there. The following topics will be addressed:

1. The gas of non-interacting fermions: tight binding models and their electronic structures
- 1.1 Excursion: Topological non-trivial materials and graphene
- 1.2 Disorder effects: General purpose numerics
- 1.3 Wavepacket dynamics in nanostructures: Krylov subspace technology

2. Elements of transport theory
- 2.1 Anderson localization in dirty quantum wires: Transfer matrix methods

3. Fermi liquid corrections
- 3.1 Briefing: Fermi-Liquid-Theory
- 3.2 Hartree-Fock method
- 3.3 Working horse for electronic structure calculations: Density functional theory

4. Strongly correlated electron systems
- 4.1 Briefing: Kondo effect
- 4.2 The numerical renormalization group
- 4.3 Briefing: Luttinger liquid
- 4.4 The density renormalization group method