Theory of disordered systems

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Outline

1. Disordered structures
   - Topological disorder: Molecular distribution functions and models
   - Disorder in crystals: impurities and alloy disorder
   - Random fractals: Mandelbrot set and percolation
   - Random walks and polymers
   - Cayley tree and gelation
2. Green's functions and the electronic structure of disordered systems
   - Definition of the one-electron Green's function
   - Formal perturbation theory
   - Impurities
   - Approximation schemes in disordered systems: VCA, SCBA, CPA
   - Scattering of free electrons from "muffin tin" potentials and KKR-CPA theory
3. Vibrational excitations in disordered systems
   - Elements of random matrix theory
   - Vibrational modes of a disordered system of coupled harmonic oscillators
   - Approximate theory: 2-site CPA and SCBA
   - Vibrational excitations in fractals
4. Electron transport in a disordered environment
   - Nearly-free-electron model and Drude-Sommerfield theory
   - Boltzmann transport equation and Ziman formula
   - Diffusion of waves
   - "Weak localization"
   - Anderson-localization of electrons
   - Quantum Hall effect
5. Hopping transport in disordered materials
   - Diffusion and Einstein relation
   - Hopping transport in crystals
   - Hopping transport in disordered solids and doped semiconductors
6. Field-theoretic description of waves in disordered systems
   - Functional-integral representation of the Green's function
   - Methods for carrying out the configuration average: Replica trick
   - Effective field theory, saddle-point and SCBA

Literature (Selection)

S. R. Elliott: *Physics of amorphous materials*, Wiley, NY, 1984

E. N. Economou: *Green's function in quantum physics*, Springer, Heidelberg, 1983

D. Stauffer, A. Aharony: *Introduction to percolation theory*

H.-J. Stöckmann: "Quantum chaos: an introduction", Cambridge Univ. Press 1999

B.I. Shklovskii, A.L. Efros: "Elecronic properties of doped semiconductors", Springer, Heidelberg, 1976

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