Statistical Physics

Topics for the complex exam

1. Foundations of statistical physics (statistical description of particle systems, statistical thermodynamics, basic ensembles)
2. Statistical mechanics of gases and liquids (ideal and real gases, virial expansion, van der Waals equation and its consequences, structure and thermodynamics of simple liquids)
3. Systems of electrically charged particles (Debye–Hückel theory, Coulomb gas model)
4. Magnetic systems (para-, dia-, and ferromagnetism, discussion of the Weiss mean-field theory)
5. Phase transitions and critical phenomena (basic models, critical exponents, the Ising model in 1D and 2D, Landau theory, renormalization group)
6. Surfaces and interfaces (statistical description, wetting, nucleation, polymers near surfaces)
7. Disordered systems (diluted magnets, models with random fields, glasses and spin glasses)
8. Ideal quantum gases (ideal Bose gas, Bose–Einstein condensation, ideal Fermi gas, Sommerfeld expansion, laws of blackbody radiation)
9. Interacting quantum fluids (interacting Bose gas and superfluidity of He, trapped Bose gases, Landau's theory of Fermi liquids, Luttinger liquid)
10. Nonequilibrium statistical mechanics (Langevin equation, Brownian motion, fluctuation-dissipation theorem)
11. Field-theoretical methods for the many-body problem (Green's function method)
12. Computational methods in statistical physics (Monte Carlo simulation, molecular dynamics, finite-size corrections)
13. Interdisciplinary applications of statistical physics (chemical reactions, biological models, traffic models, financial applications)

Recommended Literature

- L.D. Landau, E.M. Lifshitz: *Statistical Physics I, II* (Tankönyvkiadó, 1981)
- F. Reif: *Fundamentals of Statistical and Thermal Physics*
- J. Yeomans: *Statistical Mechanics of Phase Transitions*
- J.P. Bouchaud, M. Potters: *Theory of Financial Risk*
- K. Binder (ed.): *Monte Carlo Methods in Statistical Physics*