Diploma Course in Condensed Matter Physics 2012-13

Statistical Mechanics - {24 Lectures = 36 hours}

Markus Müller

Contents

1. Fundaments of statistical physics: Phase space, Liouville theorem, statistical distribution function; elements of probability theory
2. Brief review of thermodynamics: work, heat, first law, second law, entropy
3. Entropy from the statistical mechanics point of view, Nernst theorem
4. Information theoretic entropy (Shannon)
5. Thermodynamic potentials and thermodynamic stability
6. Phase equilibrium, phase diagrams, phase transitions ($1^{st}/2^{nd}$ order)
7. Van der Waals gas, Maxwell construction
8. Ensembles and their equivalence
9. Gibbs distribution and the idea of Monte Carlo simulations
10. Principles of quantum statistical mechanics
11. Classical and quantum gases (Maxwell/Boltzmann - Bose and Fermi distributions)
12. Fermions: the Fermi sea
13. Bose systems: Bose-Einstein condensation
14. Solids, phonons; radiation, Planck's law
15. Magnetic systems: Ising model, Heisenberg model
16. Mean field theory
17. Fluctuations and stability of order (Mermin Wagner theorem)
18. Critical phenomena (second order phase transitions), Goldstone modes

Grading and Exams:

Homework: Problem sheets every week.
From second week on: Hand in your solution by the evening of Wednesday 2 days before the tutorial. The homework will be graded and discussed in the tutorials. The performance in the homework contributes to the final grade.

Intermediate written exam: Somewhere at the beginning of November.
Contributes 33% to the final grade.
Final exam at the end of December – contributes 67% to the final grade.

Recommended textbooks

K. Huang: *Statistical Mechanics,* John Wiley & Sons, New York, 1987
General, good, especially for kinetics, hydrodynamics, Ising model

L. Landau & I. Lifshitz: *Statistical Physics (Vol. 5)*, Pergamon Press
General, logical structure

F. Reif: *Fundamentals of statistical and thermal physics,* McGraw-Hill Book Company
New York, 1965
General, thorough

A. Sommerfeld: *Thermodynamics and Statistical Mechanics*, Academic press, New York, 1956.
Good for traditional thermodynamics

Advanced texts:

N. Goldenfeld: *Lectures on Phase transitions and the Renormalization Group,* Frontiers in Physics, Addison Wesley, Reading Massachusetts, 1994:
Phase transitions, RG

P. Chaikin and T. Lubensky, *Principles of Condensed Matter Physics,* Cambridge University Press, 1995
Phase transitions, rich on applications to condensed matter

L. Landau & I. Lifshitz: *Statistical Physics II (Vol. 9)*, Pergamon Press
Modern Theory of quantum gases and liquids, magnetic systems

R. P. Feynman: *Statistical Mechanics – A set of lectures*, Frontiers in Physics,
Benjamin/Cummings, Reading Massachusetts, 1982
Path integrals, chosen subjects in statistical mechanics