Syllabus for Statistical Physics

Markus Müller – LB 244
http://users.ictp.it/~markusm/
markusm@ictp.it

Tutor: Yasir Iqbal – LB 233
yiqbal@ictp.it

Contents

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

Grading and Exams:

Homework: Problem sheets every week.
Send your solutions scanned by email to the tutor. The homework will be graded and discussed in the tutorials.
The performance in the homework contributes to the final grade.

Intermediate written exam: Around 20th 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