

(Prof. C. Wetterich)

I Foundations of Statistical Physics

1. Introduction

- a.) From microphysics to macrophysics
- b.) Macroscopic laws and simplicity
- c.) Fundamental laws are of probabilistic nature

2. Basic concepts of Statistical Physics

- a.) Probability distribution and expectation values
- b.) Reduced systems (subsystems)
- c.) Probabilistic observables
- d.) Quantum statistics and density matrix
- e.) Microstates
- f.) Partition function for one particle in a box
- g.) Probability distribution for continuous variable
- h.) Probability density for energy
- i.) Number of one-particle states per momentum interval
- j.) Correlation functions

3. Systems with many states or particles

- a.) Chain of N lattice sites
- b.) Uncorrelated probability distributions
- c.) Statistical ensembles
- d.) Gauss distribution
- e.) Thermodynamic limit

4. Equilibrium ensembles

- a.) Microcanonical ensemble
- b.) Canonical ensemble
- c.) Grand canonical ensemble

5. Thermodynamics

- a.) Thermodynamic potentials
- b.) Reversible and irreversible processes

II Statistical systems

6. Ideal quantum gases

- a.) Occupation number basis
- b.) Partition function for grand canonical ensemble
- c.) Occupation numbers for bosons and fermions
- d.) Photon gas
- e.) Fermi gas
- f.) Free non-relativistic bosons
- g.) Classical ideal gas
- h.) Bose-Einstein condensation

7. Gas of interacting particles

- a.) Interactions and complexity
- b.) Real Gases
- c.) Mean field approximation
- d.) Equation of state
- e.) Specific heat for real gas
- f.) Equipartition

III Phase transitions

8. First order phase transitions

- a.) Gas-liquid transition
- b.) Discontinuity

9. Second order phase transitions and critical phenomena

10. Magnetic Systems

IV Theoretical methods in Statistical Physics

11. Renormalization and flow equations

V Time evolution of probabilistic systems

12. Density matrix and von-Neumann-equation

13. Coarse graining and entropy

14. Effective time evolution equations