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Statistical Physics

Spring 2011-2012

1. Kinetic theory, Boltzmann transport equation, Liouville theorem. Boltzmann's H theorem.
2. The Gibbsian ensemble. Postulate of equal a priori probabilities and the microcanonical ensemble.
3. Canonical ensemble. The free energy. Exact solution of the Ising model in one dimension. Exact decimation procedures on hierarchical lattices – computing the free energy via the Renormalization Group.
4. Grand Canonical Ensemble. The chemical potential and fugacity. Equivalence of the different ensembles. The virial expansion.
5. Some rigorous results: Thermodynamic stability, existence and convexity of the free energy, correlation function inequalities.
6. Phase transitions. The Lee-Yang theorem.
7. Overview of critical phenomena, scaling relations. Simple applications of the Renormalization Group.
8. Quantum statistical mechanics. Bosons and Fermions. Free particles. The "statistical potential." Photons. Phonons in solids.
9. Bose systems. Imperfect Bose gas. Equation of state, Bose condensation.
10. Fermi systems. The free electron model of a metal and other applications.

K. Huang, Statistical Mechanics (Wiley, N.Y., 1987).
F. Reif, *Fundamentals of statistical and thermal physics* (McGraw Hill, Boston, 1965)
M. Plischke and B. Bergersen, *Equilibrium Statistical Physics* (World Scientific, 1994)

Other books and articles to be recommended in the course of the lectures.

HW (at least 10) %10
Quiz (at least 10) %10,
2 Midterms, total %40,
Final %40