

Phys. 541 Advanced Statistical Mechanics
Prof. Barry M. McCoy
Mon. Wed. Fri. 11:45-12:40
Physics PL-119
Syllabus for fall 2008

Modern statistical mechanics has close connections with condensed matter physics, quantum field theory and advanced mathematics. This course will present these topics with a focus on phase transitions, critical phenomena and solvable models.

The course will cover the following topics:

- 1) Theorems on the existence and non existence of order;
- 2) The phenomenology of critical phenomena and it's relation to quantum field theory;
- 3) Low density virial expansions for fluid systems;
- 4) Melting (freezing) transition of hard spheres, powerlaw, and Lenard-Jones potentials;
- 5) N vector models (known in quantum field theory as the nonlinear sigma model) will be studied by high temperature series expansions. In this context we will introduce the field theory concepts of renormalization and asymptotic freedom.
- 6) Commuting transfer matrices and the Yang-Baxter equation for integrable models. Solutions for the Ising model, the 6 and 8 vertex model, the RSOS models and the chiral Potts model will be derived.
- 7) The Ising model will be studied in great detail. In particular we will compute the free energy, spontaneous magnetization, the correlation functions and form factor expansion and we will show how renormalization theory emerges from these calculations. We will discuss the susceptibility and see that there are indications that scaling and renormalization may need to be modified.
- 8) The Bethe's ansatz solution to the 6 vertex model and Baxter's solution of the free energy of the 8 vertex model by means of the TQ equation will be presented.

There is no text but typed notes will be provided for all topics. There will be no written exams. The grade will be determined by homework, a term paper and an oral examination.

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