Phys. 541 Advanced Statistical Mechanics
Prof. Barry M. McCoy
Sylabus

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, solvable models and the interpretation in terms of quantum field theory.

The course will cover the following topics:

1) Theorems on the existence and non existence of order;

2) The phenomenology of critical phenomena and its relation to quantum field theory;

3) Low density virial expansions for fluid systems;

4) Melting (freezing) transition of hard spheres, powerlaw, and Lennard-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.

8) The Yang-Baxter equation will be derived and solved for the 6 and 8 vertex models, hard hexagons and chiral Potts.

9) The non integrable Ising model in a magnetic field will be used to explore the concepts of universality and scaling.

The text is "Advanced Statistical Mechanics" by B.M. McCoy. It is available in the book store.

Readings from the research literature and some computer based problems will will be assigned.

There will be no written exams. The grade will be determined by homework, a term paper and an oral examination.

The learning goal of the course is to know how to use and apply to current open questions in statistical mechanics and quantum field theory the results and techniques in the topics presented above.

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