8.334: Statistical Mechanics II (Spring 1980)

Special Topic: Renormalization Group and Critical Phenomena, by Professor Amnon Aharony

Spring term, MIT Rm. 4-149, Tues-Thurs 2:30-4:00 p.m.

General Description

The course will review the modern theory of phase transitions and critical phenomena. The ideas of the renormalization group (RG) will be developed and used to calculate thermodynamic properties near critical and multicritical points. Emphasis will be put on relating the results to experiments on magnetic, structural and other phase transitions.

Outline

1. Phenomenological introduction.
2. Models; Exact and numerical results.
3. Scaling and the RG.
4. RG transformations in one and two dimensions.
5. RG in 4-ε dimensions
6. Universality of exponents, amplitude ratios, scaling functions.
7. Corrections to scaling.
8. Role of symmetry and of range of interactions; dipolar interactions, cubic systems, systems with many components of the order parameter.
9. Crossover; multicritical points.
10. Tricritical points; superfluid helium, metamagnets
11. Bicritical and tetracritical points; metamagnets, structural transitions under uniaxial stress.
12. First order transitions.
13. Random systems; percolation, spin glasses, random fields.
14. Additional examples, depending on interest of audience and on time.

Main texts

1. S. K. Ma, Modern Theory of Critical Phenomena (Benjamin 1976).
2. C. Domb and M. S. Green, eds, Phase Transitions and Critical Phenomena (Academic 1976), mainly Vol. 6.