

Master iCFP / First semester course
Statistical Physics / outline

PART A : phase transitions, broken symmetries and universality...

Reminders: cumulant expansion, fluctuation-response connection...

I Introduction to phase transitions and critical phenomena

- 1- The problems raised by phase transitions, from a statistical mechanics perspective
- 2- Classification of phase transitions
- 3- Ising model : why ?
- 4- Order parameter and symmetry breakdown
- 5- Local order and correlation functions

II First order phase transitions (*mostly treated as a tutorial*)

- 1- Unstable isotherms, double-tangent and Maxwell construction
- 2- Spinodal and binodal

III Critical phenomena : qualitative approaches

- 1- Weiss molecular field
- 2- Variational mean-field and critical exponents
- 4- Landau theory
- 5- Correlation functions and Ginsburg-Landau functional

IV Beyond mean-field: fluctuations and scaling

- 1- Fluctuations
 - What do mean-field practitioners really do ?
 - Fluctuation correction to the saddle-point
 - Ginzburg criterion, crossover behaviour
 - Scattering and fluctuations: measure of structure factors
- 2- The scaling hypothesis: life with a large correlation length
 - Homogeneity and scaling relations
 - Finite size scaling: turning a drawback into an advantage

V Renormalisation group ideas

- 1- What are the problems ?
- 2- Definition of a renormalisation group transformation
- 3- Fixed points and universality
- 4- Scale invariance, critical exponents