

# Physics 670s: Advanced statistical physics

August 24, 2008

## Outline

Office: Phys 268; Email: hu4@physics.purdue.edu; Phone: 4-3044

1. Overview: Statistical physics- An overview of statistical physics and its application in various physical systems and research fields.
2. Introduction of Statistical models: Classical spin models, Quantum spin models, QCD on Lattice, Strongly correlated models- An introduction to statistical models and their applications in different fields.
3. Phase transition and critical phenomena: The concept of phase transition, symmetry breaking, Yang-Lee theorem, critical exponents and simple scaling argument.
4. Mean field theory and Landau Ginzburg theory- Mean field method and general Landau-Ginzburg theory, Phase diagram.
5. Beyond mean field: fluctuation - Saddle point solution, fluctuation corrections to the saddle point, and Ginzburg criterion.
6. Scaling and renormalization group(RG): Homogeneity assumption, scaling and universality, perturbative RG,  $\epsilon$  expansion
7. Exact solvable models: two dimension Ising model, duality and the exact solution, other exact solvable models
8. Quantum phase transition - Quantum spin models, quantum fluctuations, Quantum criticality
9. Topological defects and orders: XY model, topological defects, commensurate to incommensurate transition, quantum topological orders.
10. Non-equilibrium and dissipative dynamics Brownian motion of a particle, Brownian motion and Stochastic processes, Linear response, Transport properties, dissipative dynamics in a two level system, Non-equilibrium dynamics of open systems,
11. Disorder effect: Quenched disorder, Percolation, Random field models.

12. Numerical technique: Monte Carlo, Dynamic mean field theory, Density matrix renormalization.
  - Books recommended:
    1. L. Kadanoff, Statistical Physics Statics, Dynamics and Renormalization
    2. R. Kubo, M. Toda and N. Hashitsume, Statistical physics II
    3. Kerson Huang, Statistical physics
    4. Subir Sachdev, Quantum Phase Transition
    5. M. E. J. Newman & G. T. Barkema, Monte Carlo methods in Statistical physics
    6. James P. Sethna, Statistical Mechanics:Entropy, Order Parameters and Complexity, Website:“<http://www.physics.cornell.edu/sethna/StatMech/EntropyOrderParametersComplexity.pdf>”
    7. Assa Auerbach, “ Interacting Electrons and Quantum Magnetism” .
    8. Mucio A. Continentino, “ Quantum Scaling in Many Body Systems”
    9. P. M. Chaikin and T. C. Lubensky “ Principles of condensed matter physics”
    10. Mehram Kardar, “ Statistical physics of fields”