Outline for Fundamentals of Statistical Physics

Leo P. Kadanoff

text:
Statistical Physics,

Statics, Dynamics, Renormalization
Leo Kadanoff

I also referred often to *Wikipedia* and found it accurate and helpful.

Course Outline

part number	text chapter number	title	length (slides)	number of lectures
		Fundamentals of Statistical Physics		
1	1	Once over Lightly	16	1
2	2 & 3	Basics	24	2
3	4 & 13 &15	Quantum Mechanics and Lattices	28	3
4	5	Diffusion and Hops	24	3
5	6 & 8	Momentum hops	27	3
6	9	Bose and Fermi	16	1
7	10	Phase Transitions & mean fields	40	2
8	11 & 12 & 13 &14 &15	Phase Transitions: Beyond mean fields	42	2
				17

Part 1: Once over lightly

Concepts which specifically belong to statistical physics
Interesting Physical Science Advances have a Major Statistical Component
Probabilities: One die
Quantum Stat Mech
Classical Stat Mech
Thermodynamics
Random Walk
Brownian Dynamics
From Quantum to Classical: The Ising model
Averages from Derivatives
Degenerate Distributions
Thermodynamic Phases
Phase Transitions
Big Words

Part 2: Statistics

Part 3: On a Lattice:From Quantum to Ising to RG

Part 4: Hopping

Part 5: Time Dependence

Part 5: Time Dependence, continued

- Boltzmann Equation
  - Scattering
    - forward
    - backward
    - all together
  - Symmetries
    - detailed balance-local equilibrium
    - conservation of particle number
    - H-theorem
    - sign of dissipation term
    - dS/dt
- Homework

Part 6: Bosons and Fermions

Part 7: More is the Same

- Issues
  - Abstract
  - phases of matter
  - phase diagram water
  - basic physics in phase transitions
  - Gibbs definition; Ehrenfest classification
  - Magnetic Phase Diagram
  - a qualitative change in Behavior
  - from Gibbs to singularities
- Mean Field Theory
  - more is the same
  - for Ising model
  - Mean Field Theory is Only Partially Right
  - Calculate results
  - simplified phase diagram
  - Graph of Order Parameter
  - behavior in neighborhood of critical point
  - go after magnetization
  - go after energy
  - go after correlations
    - critical opalescence
    - basic equation
    - correlation function
    - susceptability

Part 7: More is the Same, continued

- Mean field theory of fluids
  - from van der Waals to Weiss
  - van der Waals' first effect
  - van der Waals' second effect Many Different Phase Transitions

After van der Waals

Landau Mean Field Theory
- order parameter generalized
- generalized mean field scheme
- recent example
- why minimize
- very M to vary F
- h=0, no space variation
- jump like square root of Tc-T

Summary
- order parameter and free energy were basic

Look ahead:
- a worry

Part 8: Beyond Mean Field Theory: Less is the Same too

- Periodization
- Worries about Mean Field Theory
  - fluid experiment 1
  - fluid experiment 2
  - earlier hints
  - theoretical work
  - universality
  - turbulence
  - more rumbles
- Next Steps
  - toward the revolution
  - additional phenomenology
- Block Spin
  - less is the same
  - renormalization for Ising model
  - other renormalizations
  - fields relevant, irrelevant, ...
  - a worthwhile phenomenology
- The Wilson Revolution
  - particle RG before Wilson
  - the renormalization revolution
  - crucial ideas for the revolution
  - outcome of revolution
  - conceptual advances

Part 8: Beyond Mean ... continued