PH4211 Statistical Mechanics Revision

1. Methodology of Statistical Mechanics

- Boltzmann entropy
- Gibbs entropy
- Boltzmann (canonical) distribution function
- Partition function
- Ideal gas — Identification of T
- Identical particles — Gibbs paradox ($1/N!$ factor)
- Extensivity — thermodynamic limit
- Thermal de Broglie wavelength Λ
- Classical Statistical Mechanics
- Phase space — Boltzmann and Gibbs
- "H" theorem: Liouville's theorem and 2nd Law

2. Weakly interacting systems

- Partition function — configuration integral
- Cluster expansion — f function
- Connection with viral expansion
- B_2 in various models
- Scaling / corresponding states
- Van der Waals gas

3. Strong interacting systems — Phase transitions

- Order of transition — 1st order and 2nd order
- Order parameter — Conserved / non-conserved
- Different “types” of order parameter
- Crucial — 2 different uses of the word *order*
- Symmetry breaking
- Calculations in *mean field* — neglect of *fluctuations*
- Scaling / corresponding states — (again)!
- Van der Waals — liquid-gas transition
- Double tangent construction — breaking “homogeneity”
- Weiss model ferromagnet — Weiss mean field / exchange
- Binary alloy — phase separation
- Ferroelectric
- Landau theory of phase transitions
- Landau expansion — *must* terminate, not *may* terminate
- Criterion for termination
- 2nd order / 1st order in Landau approach
- Tricritical point

4. Dissipative systems

- Fluctuations
- Autocorrelation function
- Correlation time
- Brownian motion
- Kinematics — 2 limits
- Dynamics — Langevin equation
- Langevin's separation of forces
- Friction $\propto -$velocity
- Different frames of reference
- Solution of Langevin equation — CF and PI.
- Velocity autocorrelation function and mean square velocity
- Equipartition
- Fluctuation-Dissipation theorem