Syllabus: Many Body 2 Spring 2020

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Course Description

Continuation of Many Body I with an emphasis on applications of many body techniques to understand quantum matter.

Course Requirements

- Homework 80%
- Class lecture "chalk talk" 20%

Students will give one lecture of course material during the course.

Books

- Coleman, "Introduction to Many Body Physics"
- Altland and Simmons "Condensed Matter Field Theory"
- Auerbach, "Interacting electrons and quantum magnetism"
- Goldenfeld, "Lectures on Phase Transitions and the Renormalization Group"
- Feynman, "Statistical Mechanics" and his PhD Thesis
- Negle and Orland, "Quantum Many-Particle Systems"
- Shankar, "Quantum Field Theory and Condensed Matter"

Course Content

1. Applications to Collective Phenomena of Fermions or Bosons
    - Itinerant magnetism
    - Superfluids

- Superconductors
- Disordered Electron Gas

2. Quantum Magnetism
    - Spin Waves in antiferromagnets
    - Exact Results and Theorems
    - Spin path integral
    - Low energy theory of the quantum antiferromagnet (i.e. NLσM)
    - Haldane's conjecture in 1-D (spin-1/2 vs spin-1 chain)
3. Phase Transitions
    - Landau Theory
    - Classical ϕ^4 theory and RG
    - Transverse field Ising model: quantum ϕ^4 theory
    - Bose-Hubbard model: Superfluid to insulator transition
    - Itinerant spin density wave transition ("Hertz-Millis-Moriya" theory)
    - Non-linear sigma Model (NLσM)
4. Adventures in 1D
    - Bosonization
    - Kosterlitz-Thouless: Sine Gordon model (equivalence with XY model)
    - Kondo effect and scale invariance
    - Spins $\rightarrow$ fermions $\rightarrow$ bosons: Heisenberg chain
    - Spin-1 chain: AKLT point and matrix product states