Syllabus: Many Body 2 Spring 2018

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Course Description

Continuation of Many Body I with an emphasis on applications of many body techniques.

Course Requirements

- Homework 60%
- Paper 20%
- Talk 15%
- Class lecture 5%

The paper will be approximately 10 pages long on a many body topic of the students choice (suggestions will be given at a later date). Presentation will present the topics discussed in the paper. Students will also give one lecture throughout 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. Path Integrals for particles
    - Single Particle
    - Bosons and Fermions (coherent states and then construction of the path integral)
2. Applications: Collective Phenomena
    - Itinerant magnetism
    - Superfluids
    - Superconductors
3. Spin path integral
    - Application to the antiferromagnet and Haldane's conjecture in 1-D (spin-1/2 vs spin-1 chain)
4. Phase Transitions
    - Landau Theory
    - Classical ϕ^4 theory and RG
    - Transverse field Ising model: exact solution in 1D and 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)
5. 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 compare with NLσM
    - Spin-1 chain: AKLT point and matrix product states