Methods of Statistical Physics
PHYS 603 - Spring 2017

Instructor: Brian Swingle (bswingle@umd.edu)
Lecture Time / Location: Tuesday and Thursday 9:30 AM - 10:45 AM / PHY 1402
Office Hours / Location: TBA / TBA

Description: This graduate course introduces students to the concepts and methods of modern statistical physics. The main topics are the foundations of statistical physics starting from deterministic dynamics and chaos, the statistical basis of thermodynamics, quantum statistical physics, and an exploration of phases and phase transitions. The course includes an introduction to the role of information in statistical physics and the extensive use of numerical simulations to illustrate the physics.

Lectures: Each class will consist of a mix of lectures and discussion. The typical meeting will feature an initial discussion, a lecture period, a midpoint discussion, another lecture period, and a final discussion topic to consider after class. Discussions will take place first in small groups and then with the whole group.

Tentative Schedule: (approximately 28 lectures total)

- Foundations: deterministic dynamics and chaos, the microcanonical ensemble, partition function and probabilities, entropy and information **(~6 lectures)**
- Thermodynamics: temperature and the canonical ensemble, ideal gas, laws of thermodynamics, fluctuations, black holes **(~6 lectures)**
- Quantum Statistical Physics: density matrices and mixed states, free Bose gas and blackbody radiation, Bose-Einstein condensation, free Fermi gas and metals **(~8 lectures)**
- Phases and Phase Transitions: Ising model and mean field theory, failures of mean field theory, abrupt and continuous phase transitions, coarse-graining and universality **(~8 lectures)**

Textbooks: The course does not follow any book very closely. I will provide notes to go along with the lectures. Helpful references include (but are not limited to): (1) Pathria *Statistical Mechanics*, (2) Sethna *Statistical Mechanics: Entropy, Order Parameters, and Complexity*, (3) Chandler *Introduction to Modern Statistical Mechanics,* (4) Callen *Thermodynamics and an Introduction to Thermostatics.*

Prerequisites: An introductory course on thermodynamics and statistical physics and an introductory course on quantum physics; A familiarity with probability is helpful but not required.

Grading: Grades will be tentatively based on participation in lectures (see **Lectures**), 5 Problem Sets, and 1 Final Exam. This course is a challenging one, and students are free to work with each other on the Problem Sets. However, each student must fully write up and turn in their own solutions to the Problem Sets - just turning in answers without justifications will result in lower marks.

Course Policies: http://www.ugst.umd.edu/courserelatedpolicies.html