Physics 421 — Statistical Mechanics — Spring 2014

Instructor: Pavel Kovtun, Elliott 110

Classes: Monday and Thursday, 8:30 – 9:50, Elliott 161

Office hours: Monday 10:30 – 12:30

This is a one-semester Senior undergraduate course on Statistical Mechanics. As usual, there will be regular homework assignments, a midterm exam, and a final exam. The midterm exam is on Monday, February 17-th (first Monday after the reading break).

Description: Statistical Physics is a vast subject. It includes the study of both equilibrium and non-equilibrium properties of gases, solids, liquids, phase transitions, random processes etc, using probability distributions, kinetic theory, Monte-Carlo simulations, and first-principle methods of classical and quantum mechanics. Because of the vastness of the subject and the variety of mathematical methods used, it is not uncommon that two textbooks on statistical physics will have virtually no overlapping content! Physics 421 is meant as an introduction to equilibrium statistical physics and its connection with thermodynamics. We'll go through basic statistical methods, equilbrium ensembles, microscopic description of thermodynamic quantities, and applications. We'll also go through the Bose-Einstein and Fermi-Dirac distributions relevant to quantum gases, and (time permitting) touch on superfluidity and superconductivity.

Books: The book I will mostly follow is "Fundamentals of Statistical and Thermal Physics" by F. Reif. We'll aim to cover at least the first 9 chapters of the book. The book is relatively old, but well written. You may also wish to take a look at "Statistical Physics, Part I", by Landau & Lifshitz. It is a classic book on the subject, but not as pedagogical. You may also wish to take a look at "Thermal Physics" by Kittel and Kroemer, or "Statistical Mechanics" by Schwabl. For superfluidity and superconductivity, take a look at Annett's "Superconductivity, superfluids, and condensates".

Prerequisites: I will assume that you have taken Thermodynamics, Classical Mechanics, and Quantum Mechanics. Some of the homework assignments will ask you to do computer calculations, please familiarize yourself with one of the computer programs suitable for numerical calculations such as Mathematica, Maple, or Matlab.

Homework assignments: For the homework assignments, feel free to discuss the problems with your colleagues, but the final written solution must be your own. Readings from the textbook and research papers will be regular parts of the assignments. Homework assignments (or parts thereof) submitted by email are not accepted. Late assignments are not accepted. If you can't make it to my office hours, feel free to send me an email and we'll set up an appointment.

Evaluation: Homework assignments will count for 30% of the course grade, the midterm exam will count for 20% of the course grade, and the final exam will count for 50% of the course grade. *One has to pass the final exam to get a passing grade.* The university-mandated correspondence between letter grades and percentage points is as follows: A+: 90 or more; A: 85-89; A−: 80-84; B+: 77-79; B: 73-76; B−: 70-72; C+: 65-69; C: 60-64; D: 50-59; F: below 50.