

Physics 328: Statistical Mechanics

Syllabus as taught by A. Karch, Au17

Text: *An Introduction to Thermal Physics*, Daniel Schroeder (Addison Wesley, 2000)

Recommended for further reading: *Statistical and Thermal Physics*, Gould and Tobochnik

Course Goals and Content

This is the senior level Physics UW undergraduate course in Statistical Mechanics and Thermodynamics.

Thermodynamics is the phenomenological macroscopic formalism that describes systems with very-many degrees of freedom. Thermodynamics originated from empirical observations. Statistical mechanics bridges the gap between the macroscopic and the microscopic descriptions of such large collections of particles. It explains the laws of thermodynamics and describes the fluctuations that appear when the number of degrees of freedom is smaller, ranging from Brownian motion, still visible by eye, to nano-length scale phenomena such as molecular motor transport at the biological cell level.

Quantum statistical mechanics is one of the corner stones of solid state physics, as well as particle and nuclear physics. In this course we will be able only to cover its basic features like Bose-Einstein and Fermi-Dirac statistics, and applications like the vibrational and electronic contributions to the specific heat of solids like metals, as well as Bose-Einstein condensation in gases and liquids (Helium-4). Classical statistical mechanics is just as important. Many collective phenomena associated with, e.g., phase transitions and complex network behavior are intrinsically classical.

Lecture Topics by Week (Chapter in Schroeder):

1. Review: Statistical Mechanics vs Thermodynamics (Ch. 1-2)
2. Review: Entropy (Ch 2-3)
3. Boltzmann factor and Partition function (6.1-6.5)
4. Ideal Gas (6.6-7.1)
5. Quantum gases (Ch 7)
6. Chemical potential (7.1 and 5.6-5.7)
7. Degenerate Fermi Gas (7.3)
8. Black Body Radiation (7.4)
9. Bose Einstein Condensation (7.5-7.6)
10. Ising Model (8.2)
11. Phase Transitions (notes)

Grading and Requirements:

- 20% 7 HW sets (best 6 count)
- 50% 2 midterms
- 30% Final exam.