PHYS 7540 STATISTICAL MECHANICS 2022

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FORMAT: In-person lectures on Tuesdays and Thursdays at 1pm, University College 382

TEXTBOOKS: There is no required textbook for this course. Course notes will be published online. However, you might want to consult some of the textbooks listed below:

1) LD Landau and EM Lifshitz, *Statistical Physics, Part 1* (Elsevier Butterworth-Heinemann, 1980). Excellent discussion of many of the core concepts.
2) RK Pathria, *Statistical Mechanics* (Butterworth-Heinemann).
Another good introduction into the classical topics of Stat. Mech.
3) Roger Bowley and Mariana Sánchez, *Introductory Statistical Mechanics* (Oxford Univ. Press, 1999).
This is an undergraduate textbook. It contains helpful explanations of the main ideas and is easy to read.

1. INTRODUCTION:
   - Objectives of Statistical Mechanics
   - Hamiltonian mechanics, phase space
   - Liouville theorem, Poincare theorem
   - Density operators classical and quantum
   - Dirac notation

2. BASICS OF EQUILIBRIUM STATISTICAL MECHANICS
   - Ensembles
   - Entropy
   - Partition functions, thermodynamic relations, fluctuations

3. THE IDEAL GASES
   - The classical ideal gas
   - Identical particles: Fermions and Bosons
   - The ideal Bose gas (Photon gas, vibrations of solids, Bose-Einstein condensation)
   - The ideal Fermi gas

4. BOSE-EINSTEIN CONDENSATION IN WEAKLY INTERACTING GASES
   - Cold atomic gases, traps, optical lattices

5. MAGNETIC SYSTEMS
   - The Ising model (Solution in one dimension)
   - The Hubbard and the Heisenberg model

6*. PHASE TRANSITIONS (If time permits)
   - Mean Field Theory
   - Classification of Phase Transitions: Landau theory
   - Critical exponents