A1: THERMAL AND STATISTICAL PHYSICS

Andrew Boothroyd and Alexander Schekochihin

Week	Day	Lectures		Lecturer
HILARY TERM 2013				
	PART III. FOUNDATIONS OF STATISTICAL MECAHNICS (7 lectures)			
I	WThF	1-3	Principle of maximum entropy. Canonical ensemble. Construction of thermodynamics from SM.	AS
II	WThF	4-6	SM of the classical monatomic ideal gas. Meaning and definitions of entropy (Shannon, Boltzmann, Gibbs). Meaning of probabilities. Microcanonical vs. canonical ensembles.	AS
III	W	7	Second law. Irreversibility.	AS
	Problem Set 5 on the material of Part III			
	PART IV. APPLICATIONS OF STATISTICAL MECHANICS (3 lectures)			
	Th	8	Thermodynamic calculations using the partition function: 2-level system, quantum harmonic oscillator.	AB
	F	9	Spin–1/2 paramagnet. Equipartition theorem, its application to classical systems and breakdown for quantum systems.	AB
IV	W	10	Heat capacities of Einstein solids and gases of heteronuclear diatomic molecules. Isothermal atmosphere.	AB
	PART V. OPEN SYSTEMS AND QUANTUM GASES (9 lectures)			
	Th	11	Grand canonical ensemble. Chemical potential. Thermodynamics of open systems.	AS
	F	12	Particle equilibrium. Chemical potential and the Gibbs function. Chemical potential of the classical ideal gas.	AS
V	W	13	Multispecies (multicomponent) systems. Chemical equilibrium.	AS
	Problem Set 6 on the material of Part IV & the first half of Part V (apps. and open systems)			
	ThF	14-15	Quantum gases. Pauli exclusion principle. Partition function for fermions and bosons. Occupation number statistics. Calculations in the continuous limit. Classical limit. Degeneration.	AS
VI	W	16	Degenerate Fermi gas.	AS
	Th	17	Degenerate Bose gas and Bose-Einstein condensation.	AS
	F	18	Thermal radiation: thermodynamic treatment, Kirchoff's law, Stefan–Boltzmann law, statistical treatment	AB
VII	W	19	Thermal radiation (continued): Planck's law, Wien's law, greenhouse effect, cosmic microwave background.	AB
	Problem Set 7 on the material of Part V			
	PART VI. THERMODYNAMICS OF REAL GASES (5 lectures)			
	ThF	20-21	Real gases: virial expansion; Van der Waals and Dieterici's equations; Law of Corresponding States; real gas expansions; liquefaction of gases.	AB
VIII	WThF	22-24	Phase transitions: chemical potential and phase equilibrium; Clausius–Clapeyron equation for discontinuous transitions and its solution on liquid–vapour and solid–liquid boundaries; stability and metastability; Ehrenfest's classification. Fluctuations.	AB

	Problem Set 8 (Vacation Work) on the material of Part VI + revision of Stat Mech

READING LIST

Textbook based on the Oxford course as taught up to 2011:
'Concepts in Thermal Physics,' S. J. Blundell and K. M. Blundell (2nd edition, OUP 2009)

More undergraduate textbooks:
'Fundamentals of Statistical and Thermal Physics,' F. Reif (Waveland Press 2008)
'Equilibrium Thermodynamics,' C. J. Adkins (3rd edition, CUP 1997)
'Statistical Physics,' F. Mandl (2nd edition, Wiley-Blackwell 2002)
'Elementary Statistical Physics,' C. Kittel (Dover)
[MT material] 'Thermodynamics and the Kinetic Theory of Gases,' W. Pauli (Volume 3 of Pauli Lectures on Physics, Dover 2003)

More advanced-level books:
'Statistical Thermodynamics,' E. Schroedinger (Dover 1989) [a beautiful and very concise treatment of the key topics in statistical mechanics, a bravura performance by a great theoretical physicist; may not be an easy undergraduate read, but well worth the effort!]
'Statistical Physics, Part I,' L. D. Landau and E. M. Lifshitz (3rd edition, Volume 5 of the Landau and Lifshitz Course of Theoretical Physics, Butterworth-Heinemann, 2000) [the Bible of statistical physics for theoretically inclined minds]
[MT material] 'Physical Kinetics,' E. M. Lifshitz and L. P. Pitaevskii (Volume 10 of the Landau and Lifshitz Course of Theoretical Physics, Butterworth-Heinemann, 1999)
[MT material] 'The Mathematical Theory of Non-uniform Gases: An Account of the Kinetic Theory of Viscosity, Thermal Conduction and Diffusion in Gases,' S. Chapman and T. G. Cowling (CUP 1991) [the Cambridge Bible of kinetic theory, not a page-turner, but VERY thorough]
'Statistical Physics of Particles,' M. Kardar (CUP 2007)