A1: STATISTICAL PHYSICS

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LECTURE PLAN
(approximate, subject to adjustments)

Week	Day	Lectures		Lecturer
MICHAELMAS TERM 2011				
I	PART I. KINETIC THEORY (6 lectures)			
	W	1	Statistical description of a gas. Particle distribution function. Definition of pressure in terms of particle distribution. Isotropic distributions.	AS
	Th	2	Maxwell's distribution. Temperature, pressure, equation of state for a classical ideal gas. Effusion.	AS
	Problem Set 1 can be done after this.			
II	WTh	3-4	Collisions: cross-section, collision rate, mean free path. Qualitative treatment of collisional transport: diffusion, fluxes (viscosity, heat conductivity), notion of steady state solutions to diffusion equations.	AS
III	WTh	5-6	Transport theory: kinetic equation and simplified derivation of fluid equations with collisional transport [non-examinable material].	AS
	Problem Set 2 can be started in week III.			
	PART II. FOUNDATIONS OF STAT. MECHANICS (6 lectures)			
	F	7	Shannon entropy. Second law as a fundamental principle. Lagrange multipliers. Microcanonical distribution.	AS
IV	WTh	8-9	Canonical (Gibbs/Boltzmann) distribution. Partition function. Free energy. Adiabatic change. Adiabatic invariants. Pressure. Temperature. Thermal and mechanical equilibrium. Zeroth law. Fundamental equation of thermodynamics.	AS
	F	10	First law. Concepts of heat and work. Functions of state. Relationship between the first law and the fundamental equation of thermodynamics. Heat capacity. Equation of state.	AS
V	WTh	11-12	Statistical mechanics of classical ideal gas: Distinguishability. Neglect of quantum correlations. 1-particle and N-particle partition function. Density of states. Equation of state for ideal gas. Heat capacity of ideal monatomic gas.	AS
	Problem Set 3 can be done after this.			
	PART III. BASIC THERMODYNAMICS (4 lectures)			
	F	13	Isothermal and adiabatic processes. Carnot cycles. Heat engines.	AB
VI	WThF	14-16	Entropy changes in thermodynamics. Reversible and irreversible processes.	AB

			Joule expansion. Maxwell's demon. Gibbs paradox. Thermodynamic potentials. Exact differentials. Maxwell's relations. Thermodynamic calculus.	
	Problem Set 4 can be done after this.			
	PART IV. STAT. MECH. & THERMODYN. OF SIMPLE SYSTEMS (6 lectures)			
VII	WThF	17-19	Non-gas systems: rubber band, surface tension, paramagnets. Statistical mechanics and thermodynamics of magnetic systems. Partition function of SHO. Phonons. Einstein's model of a solid.	AB
VIII	WThF	20-22	Diatomic gas. Equipartition. Third law. Adiabatic atmosphere (time permitting).	AB
	Problem Set 5 will cover this material – we recommend it be assigned as vacation work.			
Preview: HILARY TERM (everything tbc!)				
	PART V. FURTHER STAT. MECH.: QUANTUM GASES (6 lectures)			
	Problem Set 6 will be on Quantum Gases (Fermi & Bose)			
	Problem Set 7 will be on Photon Gas and Black Body Radiation			
	PART VI. FURTHER THERMODYN.: REAL GASES, PHASE TRANSITIONS (8 lectures)			
	Problem Set 8 will be on Phase Transitions, Real Gases and Inversion Curves Note: The reason this material is taught at the end of the course is that we would like the students to understand the notion of chemical potential before dealing with phase transitions etc.			

READING LIST

Textbooks based on the Oxford course in its various incarnations:

1. 'Concepts in Thermal Physics,' S. J. Blundell and K. M. Blundell (2nd edition, OUP 2009) **
2. 'Statistical Mechanics: A Survival Guide,' A. M. Glazer and J. S. Wark (OUP 2009)
3. 'Lectures on Statistical Mechanics,' M. G. Bowler (Pergamon 1982)

More undergraduate textbooks (from Berkeley, Cambridge, Manchester):

4. 'Fundamentals of Statistical and Thermal Physics,' F. Reif (Waveland Press 2008) *
5. 'Equilibrium Thermodynamics,' C. J. Adkins (3rd edition, CUP 1997) *
6. 'Statistical Physics,' F. Mandl (2nd edition, Wiley-Blackwell 2002)

A more advanced-level modern course (from MIT):

7. 'Statistical Physics of Particles,' M. Kardar (CUP 2007)

Classical books – from basic to advanced, in (approximate) order of increasing level:

8. Feynmann Lectures on Physics, Volume I (Basic Books 2011)
9. 'Thermodynamics,' E. Fermi (Dover 1956)
10. 'Thermodynamics and the Kinetic Theory of Gases,' W. Pauli (Volume 3 of Pauli Lectures on Physics, Dover 2003) *
11. 'Statistical Mechanics,' W. Pauli (Volume 4 of Pauli Lectures on Physics, Dover 2003) *
12. 'Statistical Physics, Part I,' L. D. Landau and E. M. Lifshitz (3rd edition, Volume 5 of Landau and Lifshitz Course of Theoretical Physics, Butterworth-Heinemann, 2000) *
13. 'Physical Kinetics,' E. M. Lifshitz and L. P. Pitaevskii (Volume 10 of Landau and Lifshitz Course of Theoretical Physics, Butterworth-Heinemann, 1999)
14. 'Statistical Thermodynamics,' E. Schroedinger (Dover 1989)
15. '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)