PHY 651 - Advanced Statistical Mechanics

Course Code & Number	Course Name	C.H.	Lec.	Lab.	Tut.
PHY 651	Advanced Statistical Mechanics	4	4	0	0

Syllabus

The Macroscopic View: *Thermodynamics, Thermodynamics variables, Thermodynamics limit, Thermodynamics transformations, Classical ideal gas, first law of thermodynamics, Magnetic systems.*
Heat and Entropy: *The heat equations, Applications to ideal gas, Carnot cycle, Second law of thermodynamics, absolute temperature, Temperature as integrating factor, Entropy, Entropy, of ideal gas, the limits of thermodynamics.*
Using Thermodynamics: *The energy equation, some measurable coefficients, Entropy and loss, the temperature-entropy diagram, Condition for equilibrium, Helmholtz free energy, Gibbs potential, Maxwell relations, Chemical potential.*
Phase Transpiration: *First–order phase transition, Condition for phase coexistence, Clapeyron equation, van der Waals equation of state, Viral expansion, Critical point, Maxwell construction, Scaling.*
The Statistical Approach: *The atomic view, Phase space, Distribution function, Ergodic hypothesis, Statistical ensemble, Microcanonical ensemble, The most probable distribution, Lagrange multipliers.*
Maxwell-Boltzmann Distribution: *Determining the parameters, Pressure of an ideal gas, Equipartition of energy, Distribution of speed, Fluctuations.*
Transport Phenomena: *Collisionless and hydrodynamics regimes, Navier-Stokes equation.*
Quantum Statistics: *Thermal wavelength, identical particles, Occupation numbers, Spin, Fermi statistics, Bose statistics.*
The Fermi Gas and The Bose Gas: *Fermi energy, Ground state, Fermi temperature, Low-temperature properties, Particles and holes, Electrons in solids, Semiconductors, Photons, Bose enhancement, Phonons, Debye specific heat, Electronic specific heat, Conservation of particle number.*
Bose-Einstein Condensation: *Macroscopic occupation, the condensate liquid helium.*
Canonical and Grand Canonical Ensembles: *Microcanonical ensemble, Classical canonical ensemble, The partition function, Energy fluctuations, Quantum ensemble, Quantum partition function, The particle reservoir, Grand partition function, Photon fluctuations.*
The Order Parameter: *Broken symmetry, Ising spin model, Ginsburg-Landau theory.*
Superfluidity: *Condensation wave function, Mean-field theory, Gross–Pitaevsky equation, quantum phase coherence, superfluid flow, Meissner effect.*
Stochastic Processes: *Randomness and probability, Binomial distribution, Poisson, Distribution, Gaussian distribution, Central limit theory.*
Time-Series Analysis: *Ensemble of paths, Markov process, Fokker-Planck equation, Langevin equation.*

References

- K. Huang, Introduction to Statistical Physics, Taylor & Francis, 2001.
- F. Mandl, Statistical Physics, 2nd edition, Wiley, 2000.
- W.G.Y. Rosser, An Introduction to Statistical Physics, Wiley, 1982.