
Informations

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Class schedule

13 lectures & 13 tutorials (52 h in total): <https://ernest.unistra.fr>

Literature

- P.M. Chaikin, T.C. Lubensky, *Principles of Condensed Matter Physics* (Cambridge University Press, 2000).
- D. Chandler, *Introduction to Modern Statistical Mechanics* (Oxford University Press, 1987).
- B. Diu, C. Guthmann, D. Lederer, B. Roulet, *Physique Statistique* (Hermann, 1997) [in French].
- D.L. Goodstein, *States of Matter* (Dover, 1985).
- G. Grosso, G. Pastori Parravicini, *Solid State Physics* (Academic Press, 2014)
- L. Landau, E. Lifchitz, *Course of Theoretical Physics, Volume 5 – Statistical Physics* (Pergamon Press, 1980).
- D. McQuarrie, *Statistical Mechanics* (University Science Books, 2000).
- M. Plischke, B. Bergersen, *Equilibrium Statistical Physics* (World Scientific Publishing Company, 1994).
- C. Texier, G. Roux, *Physique Statistique* (Dunod, 2017) [in French].
- J.M. Yeomans, *Statistical Mechanics of Phase Transitions* (Clarendon Press, 1992).

Program of the lectures

1. Statistical mechanics formalism

- Statistical mechanics formalism and the Shannon entropy
- Grand-canonical ensemble and application to quantum statistics

2. Ideal quantum gases

- Ideal fermion gases: high-temperature limit, degenerate Fermi gas, low-temperature Sommerfeld expansion, classical limit
- Ideal boson gases: high-temperature limit, Bose–Einstein condensation, black-body radiation

3. Interacting systems and phase transitions: the Ising model

- Introduction to the Ising model: definition and general relations, mean field theory, critical exponents
- Exact solutions in 1d and 2d
- Correlation function in the mean field approximation
- Landau theory

4. Classical fluids

- Classical fluids, multi-point correlation functions, pair correlation function
- Virial expansion
- Electrolytes and plasmas: Debye–Hückel model.

Program of the tutorials

- **Problem Set 1 – Adsorption of a gas on a surface:** grand-canonical ensemble
- **Problem Set 2 – Quantum statistics:** fermionic and bosonic ideal gases
- **Problem Set 3 – The Ising model**
- **Problem Set 4 – The liquid-gas phase transition:** lattice gas, van der Waals equation of state
- **Problem Set 5 – The Blume–Emery–Griffiths model:** Landau theory of phase transitions
- **Problem Set 6 – Aggregation of colloids:** the Debye–Hückel model
- **Problem Set 7 – Virial expansion in the grand-canonical ensemble**

Additional problem sets (not discussed in class, in French)

- **Élasticité de la laine:** les différents ensembles statistiques
- **Formalisme de la matrice densité**
- **Développement du viriel:** détente de Joule-Thomson, gaz de Tonks
- **Équation de Langevin:** introduction à la physique statistique hors-équilibre

Past written exams

Check out (and practice!) exams from the past years at http://www.ipcms.unistra.fr/?page_id=12811.