MASTER

Physique fondamentale et applications

SCIENCES SORBONNE UNIVERSITÉ

M1 – Course description MU4PYA02

<table>
<tr><td rowspan="2">Course:</td><td colspan="2">Code Apogée UE : MU4PYA02</td></tr>
<tr><td colspan="2">Nombre d'ECTS : 6</td></tr>
<tr><td>Course coordinators:</td><td>Sorbonne Université
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<tr><td>Number of hours:</td><td colspan="2">60</td></tr>
<tr><td>Semester :</td><td colspan="2">S1</td></tr>
<tr><td>Lecture localization:</td><td colspan="2">Campus Jussieu (Sorbonne Université) – Université de Paris</td></tr>
<tr><td>Laboratories:</td><td colspan="2">no</td></tr>
<tr><td>Objectives:</td><td colspan="2">Basic conceptual aspects of statistical physics and applications from solid state physics to high energy physics and cosmology</td></tr>
<tr><td>Prerequisites:</td><td colspan="2">Mandatory:

• Calculus (integral, differential, multidimensional)
• Newtonian mechanics
• Basics of thermodynamics

Useful (not mandatory):

• Basics of analytical mechanics (Lagrangian and Hamiltonian formulations, phase space)
• Elements of probability theory
• Basics of quantum mechanics</td></tr>
<tr><td>Topics/program:</td><td colspan="2"><u>Introduction</u>
From a mechanical to a statistical description of systems of many particles; The notion of equilibrium; Examples of application of statistical physics in modern science and interconnections with other disciplines and everyday life.

<u>Elements of probability theory</u>
Basic notions and definitions; Simple probability distributions (Poisson, Gauss, etc); The central limit theorem.

<u>Postulate of equal a priori probabilities and statistical ensembles</u>

• Microcanonical ensemble (phase space, density of states, Liouville theorem, ergodic hypothesis, temperature, entropy and the connection with thermodynamics)
• Canonical ensemble (thermostat, Boltzmann</td></tr>
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	distribution, partition function, entropy and free energy, equipartition theorem, fluctuations) • Grand-Canonical ensemble (generalized Boltzmann distribution, chemical potential) • Applications (ideal gas, Maxwell distribution of velocities, Lennard-Jones model of real gases, van der Waals equation of state, magnetic systems, protein folding) <u>Quantum statistics</u> • Bose-Einstein and Fermi-Dirac statistics • Classical limit and Gibbs paradox • Applications (black body radiation; Bose-Einstein condensation; Fermi gas; specific heat of molecular gases; phonons; neutron stars; quark-gluon plasma; Big Bang cosmology; electrons in a metal; superconductivity) <u>Advanced topics</u> Density Matrix; Microscopic definitions of heat and work; Master equation and Langevin equation; Irreversibility as an emergent phenomenon for macroscopic systems; Phase transitions.
Competences expected after the course:	
Bibliography:	Reif “fundamentals of statistical and thermal physics” Chandler “introduction to modern statistical mechanics”
Evaluation :	
Barèmes (Apogée) :	Ecrit : 100 /100