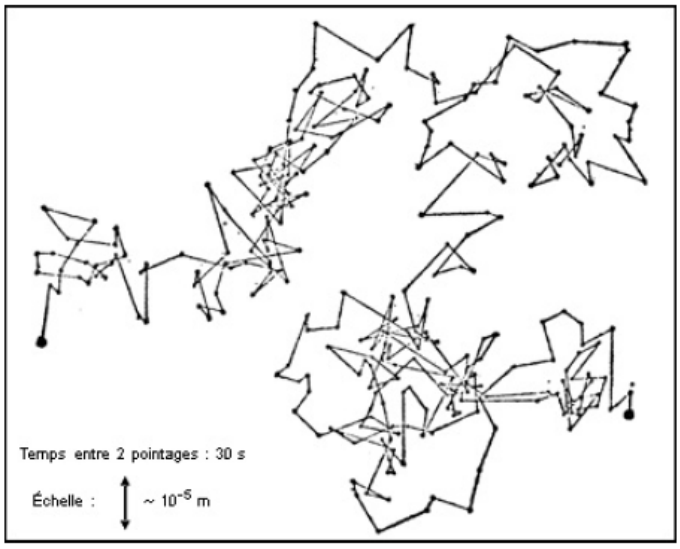
# FC1.2 Statistical physics




Supervisor: **M. Faurobert**

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Contact

✉ marianne.faurobert@oca.eu
☎ +33492076346 (supervisor)

Bibliography / links

Cours mis en ligne
Book
Statistical mechanics, Ryogo Kubo, Ed. John Wiley, North Holland

# Contents

Statistical physics aims at explaining the physical properties of macroscopic systems formed of a large number of particules from theoretical and experimental knowledge about the physics of the particules. Statistical methods allow to go from the microscopic to the macroscopic level where only the average of physical quantities and sometimes their fluctuations can be observed. The course will present the basic notions necessary for astrophysical applications. One important pedagogical aspect is that standard problems will be proposed to students as homeworks that they will then present orally to the class in the form of inversed courses.

## Part I: Basics of statistical physics

### Chapter 1: Introduction

1. The microscopic world
2. Probabilistic description
3. Classical and quantic systems. Validity domains
4. Fundamental postulate
5. Some simple examples

### Chapter 2: Equilibrium of isolated systems (micro-canonical ensemble)

1. Thermodynamic equilibrium
2. Statistical entropy
3. Equilibria between sub-systems of an isolated system.

### Chapter 3: Systems in equilibrium with a thermostat and with a reservoir

1. Equilibrium with a thermostat (canonical ensemble)
    - Partition function
    - Free energy and thermodynamical functions
    - Examples
2. Equilibrium with a reservoir (grand canonical ensemble)
    - Partition function
    - Grand potential and thermodynamical functions
    - Examples
3. Evolution towards equilibrium and Minimum principle

### Chapter 4: Identical particules

1. Identical and discernable particules
2. Boltzmann statistics
3. Grand-canonical description: Fermi-Dirac and Bose-Einstein statistics
4. Classical limit of quantum statistics, Maxwell-Boltzmann approximation

# Part II: Applications of statistical physics

## Chapter 5: Maxwell-Boltzmann statistics. Classical perfect gas

1. Partition function, internal energy, free energy
2. Specific heat and entropy of a perfect gas
3. Pressure and state equation
4. Real gas and Van der Waals approximation

## Chapter 6: Applications of quantum statistics

1. Perfect gas of fermions.
   - Fermi factor
   - Fermi gas at low temperature. Fermi energy and Pressure
   - Application to white dwarfs
2. Perfect gas of bosons
   - Bose factor
   - Bose temperature.
   - High and low temperature regimes
3. Photon gas, thermodynamics of radiation
   - Black body
   - Planck law.
   - Thermodynamical properties of the black body radiation. Radiation pressure