OVERVIEW

The CFP Master's degree is a very high-level course that offers students wishing to complete their studies in fundamental physics a wide range of advanced courses. This one leads preferentially to a thesis continuation. The specific aspect of ICFP is to give students the opportunity to build a "à la carte" course based on the choice among one of the four courses:

- Theoretical physics
- Quantum physics
- Condensed matter physics
- Macroscopic physics and complexity

A wide range of optional UEs allows for "à la carte" training.

**Language of instruction**: English  
**ECTS**: 60  
**Oriented**: research  
**Duration**: 1 year  
**Courses Location**: Ecole Normale Supérieure de Paris, Université Paris-Saclay

EDUCATIONAL OBJECTIVES

The objective of the specialization "Fundamental Concepts of Physics" is to offer students a complete and diversified training in the various fields of fundamental physics, both theoretical and experimental. The fields covered in the various proposed courses cover a wide spectrum: high-energy physics, statistical physics, quantum optics, solid-state physics, soft-matter physics, physical mechanics and
The various courses aim to prepare students for a thesis work in fundamental physics by favouring a generalist type of training. The subjects proposed by the host laboratories cover most fields of fundamental physics as well as more applied fields.

PROGRAM STRUCTURE

1. Mandatory courses

**Theoretical physics**
- Statistical physics: advanced and new applications: 6 ects, 54h courses
- Quantum field theory: 6 ects, 52h courses, 20h tutorial classes

**Quantum physics**
- Statistical physics: 6 ects, 35h courses, 15h courses
- Advanced quantum mechanics: 6 ects, 18h courses, 20h tutorial classes
- Atoms and photons: 6 ects, 26h courses, 26h tutorial classes

**Condensed matter physics**
- Structural and electronic properties of solids: 6 ects, 33h courses, 20h tutorial classes, 16h practical work
- Statistical physics: 6 ects, 36h courses, 9h tutorial classes
- Condensed matter theory: 6 ects, 39h courses, 6h tutorial classes

**Soft matter and biological physics**
- Statistical physics: 6 ects, 35h courses, 15h tutorial classes
- Physics of fluids: 6 ects, 39h courses
- Soft matter physics: 6 ects, 30h courses, 20h tutorial classes

Two or three courses (6ects) to choose among
- Numerical Physics: algorithms and computations
- Magnetism and superconductivity
- Modern electronic structure methods
- Fundamentals of nanostructures
- Biophysics
- Non linear physics and morphogenesis
- Advanced Methods in biological physics and soft matter
- Symmetries and Quantum Field Theory
- General Relativity
• Lie groups, Lie algebras and representations
• Statistical field theory and applications
• General relativity

2nd semester courses (3 ects)

• Quantum transport and mesoscopic physics
• Introduction to many body physics of fermions and bosons
• An introduction to topological order
• Physics of 2D Materials
• Quantum optics in condensed matter
• Strongly correlated Fermions and Bosons
• Novel functionalities in complex materials
• Spin Physics
• Information, Inference, Networks : from Statistical Physics to Big Biological Data
• Soft solids
• Physics of perception
• Brownian motion and stochastic processes
• Geophysical fluid dynamics
• Rheology of complex fluids
• Turbulence
• System biophysics
• Ultra cold Atoms
• Superconductors and superconducting circuits
• Quantum Information
• Non-linear, ultrafast and quantum optics
• Waves in disordered media and localization phenomena
• Quantum machines : quantum physics with electrical circuits and mechanical resonators
• Advanced Topics in Quantum Field Theory
• String Theory
• Cosmology
• Differential geometry and gauge theory
• Renormalization group theory and applications
• Introduction to Quantum Chromodynamics
• Information, Inference, Networks : from Statistical Physics to Big Biological Data
• Quantum Field Theory II
• Particle Physics : The Standard Model
• Algebra, Integrability and Exactly Solvable Models
• Selected topics in statistical field theory
• Statistical Physics2 : Disordered Systems and Interdisciplinary Applications
• Topics in Strongly Coupled Quantum Field Theory
• Complex systems : from physics to social sciences

INVOLVED LABORATORIES

• CPHT (https://www.polytechnique.edu/fr/le-centre-de-physique-theorique-cpht)
• LLR (https://www.polytechnique.edu/fr/le-laboratoire-leprince-リングュート-llr)
• PMC (https://www.polytechnique.edu/fr/le-laboratoire-de-physique-de-la-matiere-condensee-pmc)

CAREER PROSPECTS

The opportunities at the end of the thesis are mainly academic careers in universities or in major research organisation (CNRS, CEA, IN2P3) but also applied research in industry for a significant proportion of students. The Specialty prepares mainly for the professions of Basic and Applied Research, public or private, and for teaching professions.

INSTITUTIONAL PARTNERS

• Ecole Normale Supérieure
• Université Pierre et Marie Curie
• Université Paris Diderot
• Université Paris Saclay
• Ecole Polytechnique
• Université Paris Sud

TUITION FEES

ADMISSIONS

Academic Prerequisites
• BSc in physics

Language prerequisites
• English

Contact

Hache François
francois.hache@polytechnique.edu
https://portail.polytechnique.edu/lob/fr/francois-hache-directeur-du-laboratoire