

Master in Fundamental Physics and Applications

Graduate Track for Mathematics and Physics

Mise en avant

The Master's degree in Fundamental Physics and Applications (FPA) combines the requirements of a high-level research training in physics with those of a professional training. Three programs are proposed; Nanophysics (NP) and Universe and Particles (UP), which are strongly based on the research activities of Clermont-Ferrand laboratories, as well as an international course iMAPP (International Master of Advanced Methods in Particle Physics).

- The first year of the Master's degree is essentially common to the two courses NP and UP and offers courses in advanced general physics, which can serve as a basis for preparation for the competitive exam for the *agrégation* in Physical Sciences, Physics option. The courses are distinguished by an initiation to the corresponding disciplinary fields. The classroom courses are complemented by a minimum of 7-weeks internship in a company or research laboratory
- During the second year, each course offers classroom teaching and also includes a 5-months internship in a company or laboratory. The Master's degree also includes a set of courses dedicated to learning about "data sciences", offering the possibility of a degree Data Scientist delivered by UCA (University diploma)

Présentation

Enjeux

At the end of the first year of advanced general physics, the Master opens onto two M2 courses which are based on the research activities of the Photon axis of the Institut Pascal (Nanophysics course) and the research centers of the Clermont Physics Laboratory (Universe and Particles course). Each course offers a wide range of practical experiences and delivers professional skills. The international character of the training, in both its research and professional aspects, naturally opens up to a doctorate while allowing the integration of the industrial world in the field of industrial R&D. An international development council has been set up to ensure that the content and organization of the Master's program are in line with the

 UNIVERSITÉ
Clermont Auvergne

L'essentiel

Nature de la formation

1

Durée de la formation

- 2 years

Public

Niveau(x) de recrutement

- Baccalauréat +3

Langues d'enseignement

- French
- English

Modalités

- Présentiel

Lieu(x) de la formation

- Aubière

objectives of the doctoral program and the jobs targeted at the end of the M2 program.

Nanophysics

The Nanophysics (NP) course is devoted to the physical properties of matter from the microscopic or even nanometric scale to the macroscopic scale. For this purpose, it is necessary to know and master the various methods of investigation and analysis of matter using probe beams such as charged particles (electrons, ions) or photons. Knowledge in the field of materials elaboration as well as applications in nanophotonics and sensors is provided. A module on the medical applications of ionizing radiation completes this high-level scientific and technological training. The NP course is co-sponsored by Ecole Polytech via its Physical Engineering department.

Universe and Particles

The Universe and Particles (UP) program offers training in particle physics and cosmology. It is based on the research activities of the site carried out in experimental particle physics collaborations, in particular those hosted by CERN, and in observational cosmology with the flagship experiment LSST. The program also includes courses related to statistical analysis, data mining and artificial intelligence methods that train students for the Data Scientist profession. These modules are open to continuing education.

iMAPP

Since September 2021, students can opt for the iMAPP pathway (International Master "Advanced Methods in Particle Physics"), a joint program (120 ECTS) between TU Dortmund, University of Bologna and UCA. This international Master has been selected in the European program Erasmus Mundus in 2022. The 1st semester is carried out at the University of Clermont Auvergne, the 2nd semester at the University of Dortmund, the 3rd semester in Bologna and the 4th semester is the internship in a laboratory or company. The complete information is provided here: <https://imapp.eu>

Lieux

Campus des Cézeaux

Laboratoires

[Laboratoire de Physique de Clermont \(LPC\)](#)
[Institut Pascal \(IP\)](#)

Contacts

Renseignements

Responsable(s) de formation

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Pré-requis

Niveau(x) de recrutement

Baccalauréat +3

Formation(s) requise(s)

Candidates must have a degree in Physics, Physics and Chemistry or a double degree in Mathematics and Physics

Candidature

Modalités de candidature

Application to the Master in Fundamental Physics and Applications (FPA)

- Required training :

To be able to apply to the Master FPA, students must have a Bachelor's degree in Physics, a Bachelor's degree in Physics and Chemistry, or a double Bachelor's degree in Mathematics and Physics.

Required recruitment level: +3 years after Bachelor

An examination of the candidates' profile is carried out on the basis of the application file

- Application form: [Mon Master](#)

** Selection: for capacity's reasons and supervision of long internships at the end of the program, the program sets a numerus clausus for admission to M1 (first year of the Master). A selection on applications will therefore be made by the admission jury among all the students applying for the M1, whatever their original degree.*

Merit scholarship and application

The Graduate Track for Mathematics and Physics offers excellence grants to its students, up to 4,000 euros per academic year.

As part of its educational development policy, the University of Clermont Auvergne has set up a financial aid scheme for students enrolled in the Graduate Track for Mathematics and Physics.

This support is awarded according to criteria of academic excellence, motivation and quality of the study project. The grants cover the first year of the Master's program as well as the first semester of the second year, until the beginning of the internship, for a total of 16 months.

How to apply?

A specific application file must be prepared, in addition to the application file for the Master, which must contain the following elements:

- **A curriculum vitae**
- **A letter of motivation** presenting the study or research project and the reasons for your desire to come and study at the University of Clermont Auvergne in the framework of this program
- **Transcripts of your Bachelor's degree** or equivalent diploma
- **Two letters of support** from teachers or people who have worked with you in an academic and/or scientific context

APPLICATION LINKS:

FR <https://demarches.adullact.org/commencer/bourse-d-excellence-gt-maths-physique>

EN <https://demarches.adullact.org/commencer/merit-scholarship-gt-mathematics-and-physics>

Programme

Les informations ci-dessous sont données à titre indicatif et peuvent faire l'objet de mises à jour.

Universe & Particles (UP)

+

Nanophysics (NP)

Electromagnetism

EM optics

Magnetism

Projects

Quantum mechanics

Advanced methods

Relativistic Quantum Mechanics

Quantum Optics

Projects

Statistical Physics

Statistical Physics & Phase transitions

Hydrodynamics & Astrophysics

Deformable Solid Mechanics

Projects

Mathematics

Mathematics

Numerical methods

9 ECTS

9 ECTS

9 ECTS

3 ECTS

International Master of Advanced Methods in Particle Physics (iMAPP)

Quantum Field Theory, Gauge Theories & Quantum ChromoDynamics

Quantum Field Theory

Gauge Theories

Quantum ChromoDynamics

Fondations of the standard model of Particle Physics
Introduction to Particle Physics
Symmetries in Physics
Electroweak standard model (inc. flavour physics)

Programming and data analysis
Programming
Data structures and mining

Statistics and artificial intelligence
Statistics
Machine Learning

Option 1: Guest lectures on various topics (related to PP)

Option 2: UCA seminars on particle physics

Research internship (+ English skills)

6 ECTS

9 ECTS

6 ECTS

6 ECTS

3 ECTS

3 ECTS

6 ECTS

Semester 2

Universe & Particles (UP)

+

Nanophysics (NP)

Experimental methods
Lab I: astrophysics
Lab II: Electronics (Arduino)
*Lab III: Instrumentation (Rutherford, Landé factor,
radio astronomy, laser)*

Physics of matter at different scales

Nuclear Physics

Solid state Physics

Projects: nuclear reactors and society, electronic microscopy

Specialisation (elective module) choice:

Universe & Particles

Nanophotonics

Research internship (+ English skills)

9 ECTS

9 ECTS

6 ECTS

6 ECTS

International Master of Advanced Methods in Particle Physics (iMAPP)

Theoretical particle physics

Experimental aspects of particle physics

Detector system in particle & medical physics

Option 1:

Electronics Lab. Course

Modern Particle Physics

Astroparticle Physics

Option 2:

Guest lectures on recent results (high energy physic)

TUDO seminars on particle physics

6 ECTS

6 ECTS

6 ECTS

6 ETCS
6 ETCS
6 ECTS

3 ECTS
3 ECTS

Second year

Semester 3

Universe & Particles (UP)

Data Analysis & Statistics
Data Analysis with Python
Statistics

Detectors for HEP & Cosmology – Experimental projects
Detectors
Experimental projects

Symmetries & Particle Physics
Symmetries
Introduction to Particle Physics

Quantum Field Theory & Quantum ChromoDynamics
Quantum Fiel Theory
Quantum ChromoDynamics

Data Mining & ML
Data Mining
Machine Learning

6 ECTS

6 ECTS

6 ECTS

6 ECTS

6 ECTS

Nanophysics (NP)

Professional Insertion & Project Supervision

Data Analysis & Statistics

Data Analysis with Python

Statistics

Light-Matter Interaction & Symmetries

Light-Matter Interaction

Symmetries

Sensors

Numerical Simulations & Theoretical Modelling in Physics

Finite difference time domain

Spectral methods

Monte-Carlo methods

Finite element method

Nanostructures & Photonics-Plasmonics

Physics of nanostructures

Photonics-Plasmonics-Nano-Materials

3 ECTS

6 ECTS

6 ECTS

3 ECTS

6 ECTS

6 ECTS

Semester 4

Universe & Particles (UP)

Electroweak Physics

QED (Quantum ElectroDynamics & Gauge Theories)

Electroweak Standard Model

Flavour Physics (Quarks and Leptons)

General Relativity & Cosmology

General Relativity

Cosmology

Research internship (+ English skills)

6 ECTS

6 ECTS

18 ECTS

Nanophysics (NP)

Epitaxy & Interfaces

Epitaxy, Quantum methods in solids

Surfaces, interfaces

Exp. techniques of elaboration & analysis, seminars

Exp. techniques of elaboration & analysis

Seminars on Nanophysics

Research internship (+ English skills)

6 ECTS

6 ECTS

18 ECTS

Stage(s)

Stage(s)

Oui, obligatoires

Informations complémentaires sur le(s) stage(s)

Internships are mandatory in a company or laboratory:

- In 1st year: 7weeks minimum
- In 2nd year: 5-months minimum

Séjour(s) à l'étranger

Informations complémentaires sur le(s) séjour(s) à l'étranger

The Fundamental Physics and Applications field is based on international research activities. The 2nd year courses for both tracks are taught in English. Each course is based on close connections with partner universities in the world which offer privileged possibilities of internships in the 2nd year of the Master's program abroad.

Et après ?

Niveau de sortie

Année post-bac de sortie

- Bac +5

Compétences visées

Activités visées / compétences attestées

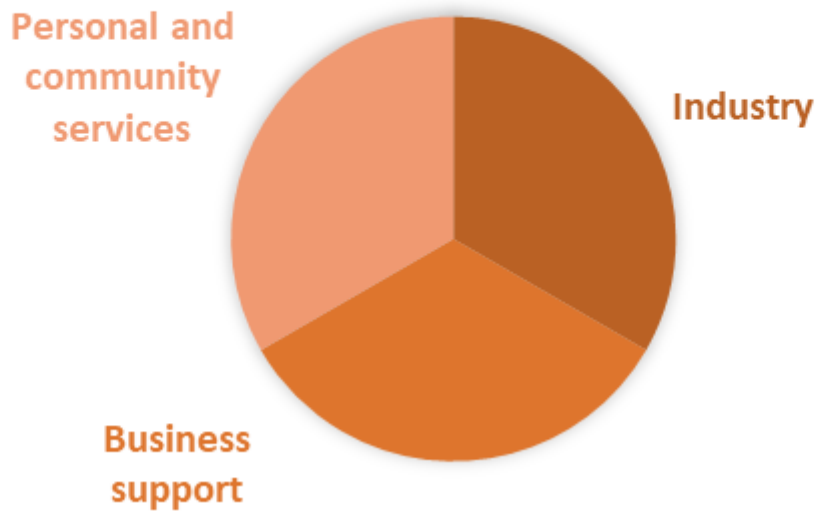
The Master's program offers many practical and experimental situations, to develop skills including the following aspects:

- Adapting a theoretical framework to describe a phenomenon in a formal and numerical way
- Leading an innovative scientific project and conducting it in a collaborative framework
- Drawing up a state of the art experiment in a scientific research field
- Communicating orally and writing in French and English in a scientific context
- Using abstraction skills to interpret a real phenomenon
- Mastering advanced mathematical tools for calculation and modeling in physics
- Developing an experimental protocol to solve a physical problem

Débouchés professionnels

Secteurs d'activité

BUSINESS SECTORS



Training by and for research, the Fundamental Physics and Applications specialization has a dual objective in terms of jobs and skills: academic research through the University thesis on the one hand, and jobs in teaching and industrial R&D on the other. These generic objectives are shared by the two courses. However, there are specific skills for each pathway:

- The courses related to numerical simulations in the Nanophysics program provide skills that are immediately transferable to industrial R&D careers
- About 100 hours in M2 Universe and Particles are devoted to courses related to statistical data analysis, data mining and artificial intelligence techniques. The aim is to open up new career opportunities as a data scientist.

Insertion professionnelle

Nanophysics:

Survey 2020_class of 2019: less than 1 year from graduation:

- 22% working
- 11% looking for an occupation
- 66% in PhD

Universe and Particles:

Survey 2020_class of 2019: less than 1 year from graduation:

- 12% looking for a job
- 88% in PhD