UCLouvain

PHYS2M1

2023 - 2024

Master [60] in Physics

At Louvain-la-Neuve - 60 credits - 1 year - Day schedule - In English
Dissertation/Graduation Project : **YES** - Internship : **NO**
Activities in English: **YES** - Activities in other languages : **NO**
Activities on other sites : **NO**
Main study domain : **Sciences**
Organized by: **Faculty of Science (SC)**
Programme acronym: **PHYS2M1** - Francophone Certification Framework: 7

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PHYS2M1 - Introduction

Introduction

Introduction

The physicist possesses great capacities of reasoning and abstraction. He.she continually asks questions about the physical world around him.her in order to understand how it works. He.she observes, makes assumptions, formalizes concepts, and writes and solves the equations governing them in order to confront them with observations and experience. Thanks to his.her advanced and versatile scientific training, he.she contributes to the great challenges of the Society of today and tomorrow. He.she is involved in cutting-edge research and the resolution of important questions related to the genesis and evolution of the Universe, fundamental interactions between elementary particles, quantum optics, statistical physics, origins of the Earth, global climate change, sustainable development, energy choices, etc.

The skills developed by the physicist as part of his.her training, including his.her ability to model and characterize large data sets, can be valued in many professions specific to the realms of today’s physics, such as superconductivity, instrumentation and metrology, laser physics, nuclear physics, nonlinear physics, cosmology, astrophysics, astronomy, planetology, geophysics, meteorology, climatology, oceanography and glaciology, or fields as diverse as medical sciences, space sciences and signal processing, but also actuarial sciences, finance, consultancy, banking and all areas where statistical methods, IT and tools related to artificial intelligence are important. Through his.her teamwork skills, the physicist also develops skills in communication, scientific popularization and management. His.her various skills enables him.her to contribute to the creation of tomorrow’s jobs.

The objective the Master [120] in Physics is to enable you : (1) to master the fundamental laws and essential tools of today's physics and (2) to acquire disciplinary skills and cross-cutting essential to exercise a professional activity related to physics. It does not give access to the PhD in Science.

Your profile

You hold a Bachelor's degree in physics or a Bachelor’s or Master’s degree in a discipline related to physics and you want complete in one year your training in physics. You then have the profile to begin a Master [60] in Physics. You will have the chance to receive a personalized training with internationally recognized teachers.

Your future job

The training in physics aims at mastering advanced physical and mathematical tools. It develops skills such as curiosity and scientific rigor, the capacity for abstraction, the modeling of complex physical problems, the sense of precision and experimental measurement as well as the ability to work in a team and to communicate.

Thanks to this versatile training, there are many career opportunities.

One main track is to start a career in research (university laboratories, private laboratories, European Organization for Nuclear Research - CERN, Atomic Energy Commission, Institute for Space Aeronomy of Belgium, Royal Meteorological Institute of Belgium, Royal Observatory of Belgium , etc.) or in secondary or higher education (high schools).

Physicists also find jobs in the private or financial sector. Some of them work in the medical area as a hospital physicist, in the high technology industry (telecommunications, optics, aeronautics, space industry, medical equipment, etc.), in the field of energy, in the area of information technology (big data processing, design of calculation programmes, etc.), for banks and insurance companies, in the field of environmental consultancy and in the sector of scientific communication and popularization.

Your programme

The programme of the Master [60] in Physics, which can be completed in one year, offers :

- an advanced and specialized training in physics,
- teaching units taught, for most of them , in English,
- a lot of practical works (exercises, laboratories, and personal or group projects),
- the possibility to conduct research within the Master’s thesis in one of the research institutes of UCLouvain, one of the federal scientific institutes in which academic members of the School of Physics work or a private company.

PHYS2M1 - Teaching profile

Learning outcomes

Observe and understand the physical reality of the world around him.her, understand it, explain it and model it, these are the challenges that the student enroled in the Master [60] in Physics is preparing to meet. This programme aims to develop mastery of the fundamental laws and essential tools of today's physics. It leads to the acquisition of skills such as the ability to analyze a physical problem, the ability of abstraction and modeling, the rigor in reasoning and expression, the autonomy and the ability to communicate, including in English.

At the end of his.her training at the Faculty of Sciences, the student will have acquired the disciplinary and cross-disciplinary knowledge, and skills needed to perform numerous professional activities. His.her modeling and in-depth understanding of phenomena, his.her liking for research and his.her scientific rigor will be sought not only in scientific professions (research, development, teaching, etc.), but also more generally in the current and future Society.

On successful completion of this programme, each student is able to :

1. Master and use in depth the specialized knowledges of physics.

1.1 Formulate the fundamental concepts of current physical theories, highlighting their main ideas, and link these theories together.

1.2 Identify and apply physical theories to solve a problem.

1.3 Know and use adequately the principles of experimental physics : measurements, their uncertainties, measuring instruments and their calibration, the processing of data by computer tools.

1.4 Explain and design a measurement method and implement it.

1.5 Model complex systems and predict their evolution using numerical methods, including computer simulations.

1.6 Retrace the historical evolution of physical concepts and recognize the role of physics in various parts of the body of knowledge and culture.

2. Demonstrate methodological, technical and practical skills useful for solving problems in physics.

2.1 Choose, knowing their limitations, a method and tools to solve a novel problem in physics.

2.2 Design and use instruments to measure or study a physical system.

2.3 Properly handle computer tools to help solve problems in physics, while knowing the limitations of these tools.

2.4 Design algorithms adapted to the problems addressed and translate them into computer programmes.

2.5 Apply adequate tools, both basic and more advanced, to model complex physical systems and solve specific problems in physics application fields.

3. Apply a scientific approach and reasoning, and identify, using an inductive or deductive approach, the unifying aspects of different situations and experiences.

3.1 Evaluate the simplicity, clarity, rigor, originality of a scientific reasoning, and identify any flaws.

3.2 Develop or adapt a physical reasoning and formalize it.

3.3 Argue the validity of a scientific result and adapt its argumentation to various audiences.

3.4 Show the analogies between different problems in physics, in order to apply known solutions to new problems.

4. Build new knowledge and research related to issues in one or more areas of current physics.

4.1 Develop an autonomous physical intuition by anticipating expected results and verifying consistency with existing results.

4.2 Analyze a research problem and select the appropriate tools to study it in a thorough and original way.

5. Learn and act autonomously to continue training in an independent way.

5.1 Search in the physical literature for sources and assess their relevance.

5.2 Read and interpret an advanced physics text and relate it to acquired knowledge.

5.3 Acquire new scientific and technical skills.

5.4 Judge autonomously the relevance of a scientific approach and the interest of a physical theory.

6. Work in a team and collaborate with students and professionals in other disciplinary fields to achieve common goals and produce results.

6.1 Share knowledge and methods.

6.2 Identify individual and collective goals and responsibilities, and work in accordance with these roles.

6.3 Manage, individually and as a team, a major project in all its aspects.

6.4 Evaluate your performance as an individual and team member, and evaluate the performance of others.

6.5 Recognize and respect the views and opinions of team members.

7. Communicate effectively in French and English (C1 CEFR level) and in a way that is appropriate for the intended audience

7.1 Write scientific texts in accordance with the conventions and specific rules of the discipline.

7.2 Structure an oral presentation and bring out the key elements of the subject.

8.1 Achieve a level of expertise in a chosen field of contemporary physics.

8.2 Deepen a subject beyond current knowledge.

Programme structure

The programme leading to the Master's [60] degree in physics includes :

- 30 credits of specialized training in physics, to be chosen from a list of teaching units organized into subject blocks,
- 2 credits of training in human sciences, to be chosen from a list of teaching units,
- 18 credits of activities related to the Master's thesis,
- 10 credits of elective teaching units, to be selected from a list of teaching units organized into subject blocks.

Typical programmes, according to the different orientations of the research in physics carried out at UCLouvain, are proposed on the website of the School of Physics in the "Education and Training" section. There are nine of them. They relate to :

- statistical physics and mathematical physics,
- formal aspects of fundamental interactions,
- theory and phenomenology of fundamental interactions,
- experimentation in physics of fundamental interactions,
- instrumentation in physics of fundamental interactions,
- atomic, molecular physics and optics from the theoretical point of view,
- atomic, molecular physics and optics from the experimental point of view,
- physical climatology,
- physics of the Earth and planets.

PHYS2M1 Programme

Detailed programme by subject

CORE COURSES [50.0]

- Mandatory
- Optional
- Not offered in 2023-2024
- Not offered in 2023-2024 but offered the following year
- Offered in 2023-2024 but not the following year
- Not offered in 2023-2024 or the following year
- Activity with requisites
- Open to incoming exchange students
- Not open to incoming exchange students
- [FR] Teaching language (FR, EN, ES, NL, DE, ...)

Click on the course title to see detailed informations (objectives, methods, evaluation...)

Formation spécialisée en physique (30 credits)

NB : Des programmes types en fonction des orientations de la recherche en sciences physiques à l'UCLouvain sont proposés sur le site Web de l'école de physique. L'étudiant·e choisit 30 crédits parmi :
The students have to choose 28 credits minimum between the following courses

Physique statistique et mathématique

LPHYS2112	Mathematical physics	Christophe Ringeval	[EN] [q1] [30h] [5 Credits] > *French-friendly*
LPHYS2113	Critical phenomena	Philippe Ruelle	[EN] [q1] [22.5h+7.5h] [5 Credits] > *French-friendly*
LPHYS2114	Nonlinear dynamics	Michel Crucifix	[EN] [q1] [22.5h+22.5h] [5 Credits] > *French-friendly*

Gravitation, cosmologie et astroparticules

⊠ LPHYS2122	Cosmology	Christophe Ringeval	EN [q1] [30h] [5 Credits] > *French-friendly*

⊠ Physique des particules

⊠ LPHYS2131	Fundamental interactions and elementary particles	Agni Bethani (compensates Christophe Delaere) Céline Degrande Christophe Delaere Vincent Lemaitre	EN [q1] [52.5h+7.5h] [10 Credits] > *French-friendly*
⊠ LPHYS2132	Quantum field theory 1	Céline Degrande Marco Drewes	EN [q1] [52.5h+7.5h] [10 Credits] > *French-friendly*

⊠ Physique atomique, moléculaire et optique

⊠ LPHYS2141	Introduction to quantum optics	Matthieu Génévriez Xavier Urbain	EN [q1] [22.5h+7.5h] [5 Credits] > *French-friendly*
⊠ LPHYS2143	Optics and lasers	Clément Lauzin	EN [q1] [22.5h+22.5h] [5 Credits] > *French-friendly*

⊠ Physique de la Terre, des planètes et du climat

⊠ LPHYS2161	Internal geophysics of the Earth and planets	Véronique Dehant (coord.) Jérémy Rekier	EN [q1] [22.5h+7.5h] [5 Credits] > *French-friendly*
⊠ LPHYS2162	Introduction to the physics of the climate system and its modelling	Hugues Goosse Francesco Ragone	EN [q1] [22.5h+22.5h] [5 Credits] > *French-friendly*
⊠ LPHYS2163	Atmosphere and ocean : physics and dynamics	Thierry Fichefet François Massonnet	EN [q1] [52.5h+7.5h] [10 Credits] > *French-friendly*

⊠ Instrumentation et méthodes numériques

⊠ LPHYS2101	Analog and digital electronics	Eduardo Cortina Gil	EN [q1] [45h+45h] [10 Credits] > *French-friendly*
⊠ LPHYS2102	Ionizing Radiation Detection and Nuclear Instrumentation	Eduardo Cortina Gil	EN [q1+q2] [26h+26h] [5 Credits]

○ Formation en sciences humaines (2 credits)

L'étudiant·e choisit une UE parmi :

⊠ LSC2001	Introduction to contemporary philosophy	Peter Verdée Peter Verdée (compensates Charles Pence)	FR [q2] [30h] [2 Credits]
⊠ LSC2220	Philosophy of science	Alexandre Guay	EN [q2] [30h] [2 Credits]
⊠ LFILO2003E	Ethics in the Sciences and technics (sem)	Alexandre Guay (compensates Charles Pence) Hervé Jeanmart René Rezsohazy	FR [q2] [15h+15h] [2 Credits]
⊠ LTHEO2840	Science and Christian faith	Benoît Bourgine Paulo Jorge Dos Santos Rodrigues	FR [q1] [15h] [2 Credits]

○ Activities linked to the individual final project (18 credits)

○ LPHYS2198	Master's thesis		EN [q1+q2] [] [16 Credits] > *French-friendly*
○ LPHYS2197	Thesis tutorial	Ahmed Adrioueche Gwenhaël de Wasseige	EN [q1] [15h] [2 Credits] > *French-friendly*

⊠ Optional courses

These credits are not counted within the 60 required credits.

⊠ LSST1001	IngénieuxSud	Stéphanie Merle Jean-Pierre Raskin (coord.)	FR [q1+q2] [15h+45h] [5 Credits]
⊠ LSST1002M	Information and critical thinking - MOOC	Myriam De Kesel Jean-François Rees	FR [q2] [30h+15h] [3 Credits]

UE au choix [10.0]

UE AU CHOIX [10.0]

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Click on the course title to see detailed informations (objectives, methods, evaluation...)

Content:

Physique statistique et mathématique

LPHYS2211	Group theory	Philippe Ruelle	EN [q2] [22.5h+22.5h] [5 Credits] > *French-friendly*
LPHYS2215	Statistical field theory		EN [q2] [30h] [5 Credits] > *French-friendly*

Gravitation, cosmologie et astroparticules

LPHYS2221	Astrophysics and astroparticles	Gwenhaël de Wasseige	EN [q2] [30h] [5 Credits] > *French-friendly*
LPHYS2223	utrino physics and dark matter	Marco Drewes	EN [q2] [30h] [5 Credits] > *French-friendly*
LPHYS2224	Advanced cosmology and general relativity	Christophe Ringeval	EN [q2] [30h] [5 Credits] > *French-friendly*

Physique des particules

LPHYS2233	Experimental methods in fundamental physics	Agni Bethani (compensates Giacomo Bruno) Giacomo Bruno Eduardo Cortina Gil	EN [q2] [52.5h+7.5h] [10 Credits] > *French-friendly*
LPHYS2234	Quantum field theory 2	Marco Drewes	EN [q2] [30h] [5 Credits] > *French-friendly*

Physique atomique, moléculaire et optique

LPHYS2242	Fundamentals of quantum information		EN [q2] [30h] [5 Credits] > *French-friendly*
LPHYS2244	Molecular physics	Clément Lauzin	EN [q2] [22.5h+7.5h] [5 Credits] > *French-friendly*
LPHYS2245	Lasers physics	Clément Lauzin	EN [q2] [22.5h+7.5h] [5 Credits] > *French-friendly*
LPHYS2246	Experimental methods in atomic and molecular physics	Clément Lauzin Xavier Urbain	EN [q2] [30h] [5 Credits] > *French-friendly*
LPHYS2247	Special topics in quantum optics	Matthieu Génévriez	EN [q2] [30h] [5 Credits] > *French-friendly*
LPHYS2248	Ultra-fast laser physics	Clément Lauzin	EN [q2] [22.5h+7.5h] [5 Credits] > *French-friendly*

Physique de la matière condensée et des milieux continus

LMAPR2451	Atomistic and nanoscopic simulations	Jean-Christophe Charlier Xavier Gonze Gian-Marco Rignanese	EN [q2] [30h+30h] [5 Credits] > *French-friendly*

⊠ Physique de la Terre, des planètes et du climat

⊠ LPHYS2260	Geodesy and GNSS (Global Navigation Satellite System)	Véronique Dehant (coord.) Sébastien Le Maistre Jérémy Rekier	EN [q2] [30h] [5 Credits] ⊕ > *French-friendly*
⊠ LPHYS2264	Oscillations and instabilities in the climate system	Michel Crucifix	EN [q2] [30h] [5 Credits] ⊕ > *French-friendly*
⊠ LPHYS2265	Sea ice-ocean-atmosphere interactions in polar regions		EN [q2] [30h] [5 Credits] ⊘ > *French-friendly*
⊠ LPHYS2266	Physics of the upper atmosphere and space	Viviane Pierrard	EN [q2] [22.5h+7.5h] [5 Credits] > *French-friendly*
⊠ LPHYS2267	Paleoclimate dynamics and modelling	Qiuzhen Yin	EN [q2] [22.5h+7.5h] [5 Credits] > *French-friendly*
⊠ LPHYS2268	Forecast, prediction and projection in climate science	François Massonnet	EN [q2] [22.5h+7.5h] [5 Credits] > *French-friendly*
⊠ LPHYS2269	Remote sensing of climate change	Emmanuel Dekemper	EN [q2] [30h] [5 Credits] ⊘ > *French-friendly*

⊠ Compléments de mathématique

⊠ LMAT2130	Partial differential equations	Heiner Olbermann	EN [q1] [30h+15h] [5 Credits]
⊠ LMAT2160	Training seminar for mathematical researchers	Pierre-Emmanuel Caprace Jean Van Schaftingen	EN [q1] [15h] [5 Credits] > *English-friendly*
⊠ LMAT2250	Calculus of variations		FR [q2] [30h+15h] [5 Credits] ⊘ > *English-friendly*
⊠ LMAT2420	Complex analysis	Tom Claeys	EN [q2] [30h+15h] [5 Credits] > *French-friendly*
⊠ LMAT2470	Processus stochastiques (statistique)	Donatien Hainaut	FR [q2] [30h] [5 Credits] > *English-friendly*

Supplementary classes

To access this Master, students must have a good command of certain subjects. If this is not the case, students must take supplementary classes chosen by the faculty to satisfy course prerequisites.

Rem : These additional teaching units (maximum 60 credits) will be selected in the programme of the second and third annual units of the Bachelor's degree in physics, in consultation with the Study advisor, depending on the previous teaching units followed by the student and his.her training project, and will be submitted to the approval of the School of Physics.

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Click on the course title to see detailed informations (objectives, methods, evaluation...)

Enseignements supplémentaires

The programme's courses and learning outcomes

For each UCLouvain training programme, a reference framework of learning outcomes specifies the the skills expected of every graduate on completion of the programme. Course unit descriptions specify targeted learning outcomes, as well as the unit's contribution to reference framework of learning outcomes.

PHYS2M1 - Information

Access Requirements

Master course admission requirements are defined by the French Community of Belgium Decree of 7 November 2013 defining the hiher education landscape and the academic organisation of courses.

General and specific admission requirements for this programme must be satisfied at the time of enrolling at the university.

Unless explicitly mentioned, the bachelor's, master's and licentiate degrees listed in this table or on this page are to be understood as those issued by an institution of the French, Flemish or German-speaking Community, or by the Royal Military Academy.

In the event of the divergence between the different linguistic versions of the present conditions, the French version shall prevail.

SUMMARY

Specific access requirements

Students who wish to be admitted on the basis of a dossier (see tables below) are invited to consult the criteria for the evaluation of application.

University Bachelors

Diploma	Special Requirements	Access	Remarks
UCLouvain Bachelors			
Bachelor in Physics		Direct access	
Bachelor in Mathematics	Si l'étudiant a suivi la Minor in Physics	Access based on application	In some cases, the UCLouvain Enrolment Office, after reviewing their online enrolment or re-enrolment application, will ask the students concerned to provide an enrolment authorisation from the faculty/ school.
Bachelor in Geography : General	Si l'étudiant a suivi la Minor in Physics	Access based on application	In some cases, the UCLouvain Enrolment Office, after reviewing their online enrolment or re-enrolment application, will ask the students concerned to provide an enrolment authorisation from the faculty/ school.
Bachelor in Engineering	Si l'étudiant a suivi la Minor in Physics	Access based on application	In some cases, the UCLouvain Enrolment Office, after reviewing their online enrolment or re-enrolment application, will ask the students concerned to provide an enrolment authorisation from the faculty/ school.
Others Bachelors of the French speaking Community of Belgium			
		Direct access	

Bachelier en sciences de l'ingénieur - orientation ingénieur civil	Access with additional training
Bachelors of the Dutch speaking Community of Belgium	
	Direct access
Foreign Bachelors	
	Direct access

Non university Bachelors

> Find out more about links to the university

Holders of a 2nd cycle University degree

Diploma	Special Requirements	Access	Remarks
"Licenciés"			
		-	
Masters			
		-	

Holders of a non-University 2nd cycle degree

Access based on validation of professional experience

> It is possible, under certain conditions, to use one's personal and professional experience to enter a university course without having the required qualifications. However, validation of prior experience does not automatically apply to all courses. Find out more about Validation of priori experience.

Access based on application

Access based on application : access may be granted either directly or on the condition of completing additional courses of a maximum of 60 ECTS credits, or refused.

The first step in the procedure is to submit a file online (see https://uclouvain.be/en/study/inscriptions/futurs-etudiants.html).

Students who wish to be admitted on the basis of a dossier are invited to consult the criteria for the evaluation of application.

Admission and Enrolment Procedures for general registration

Teaching method

Most teaching units are given by default in English.

Various teaching methods are used : lectures, flipped classroom, project-based learning, etc. Exercise and practical lab sessions are organized for certain teaching units. Individual or group projects are planned for most of the teaching units. These projects play a significant role (around 20%) in the final grade.

Almost all teaching units have a website on the MoodleUCL platform. Useful information is provided, as well as syllabi and other documents essential to student's work.

The Master's thesis is a formative activity that must lead students to demonstrate their ability to (1) deal in depth with a physical problem in all its real complexity, by conducting a personal research, under the direction of a promoter, and (2) write a summary of his.her work and defend it in public in a rigorous and educational way, while being able to answer relatively specific questions. The various stages are : constitution of a relevant bibliography on the subject, reading and understanding of the selected articles, implementation and execution of the project, analysis and interpretation of the results obtained, writing of a synthesis manuscript and oral presentation of the latter. To carry out this project, the student is embedded in a research group with which he.she can interact.

A "thesis tutorial" introduces the student to scientific communication and, in particular, to the oral presentation of a scientific subject in English.

Evaluation

The evaluation methods comply with the regulations concerning studies and exams (https://uclouvain.be/fr/decouvrir/rgee.html). More detailed explanation of the modalities specific to each learning unit are available on their description sheets under the heading "Learning outcomes evaluation method".

The evaluation methods are in accordance with the regulations for studies and examinations. More details on the terms and conditions specific to each teaching unit are available in their fact sheet under the heading "Assessment of student achievement".

The student is evaluated on the basis of the personal work that he.she will have accomplished (readings, consultation of databases and bibliographical references, writing of monographs and reports, presentation of seminars, dissertation, etc.). When the training requires it, the student is also evaluated regarding his.her ability to assimilate the masterly taught subject. The evaluation of the Master's thesis is based on the work performed during the year and its written and oral presentation.

To obtain the average, the marks obtained for the different teaching units are weighted by their respective credits.

If a student enroled in an exam at the January session has not been able to present the examination for reasons of force majeure which are duly justified, he.she may ask the President of the Jury for permission to present the examination at the June session. The President of the Jury judges the relevance of the application and, if the course owner agrees, may authorize the student to present the examination at the June session.

Possible trainings at the end of the programme

The only university programme directly accessible from the Master [60] in Physics is the Agrégation de l'enseignement secondaire supérieur (30 credits). It is also possible to complete in one year the Master [120] in Physics giving access to the PhD in Science and specialized Masters. The attention of students is drawn to the fact that such a course requires the submission of two Master's theses and may include up to 15 credits of additional teaching units.

Contacts

Curriculum Management

Entity

Structure entity	SST/SC/PHYS
Denomination	(PHYS)
Faculty	Faculty of Science (SC)
Sector	Sciences and Technology (SST)
Acronym	PHYS
Postal address	Chemin du Cyclotron 2 - bte L7.01.04 1348 Louvain-la-Neuve Tel: +32 (0) 10 47 32 94 - Fax: +32 (0) 10 47 30 68
Website	https://uclouvain.be/fr/facultes/sc/phys

Academic supervisor: Vincent Lemaitre

Jury

- Eduardo Cortina Gil
- Christophe Delaere
- François Massonnet
- Céline Degrande

Useful Contact(s)

- Catherine De Roy