



# Master Physique

## Astrophysics and Data Science

### Présentation

#### English presentation:

Recent advances in physics (high energy physics, quantum physics, condensed matter...) and related disciplines (astrophysics, life sciences, medical treatment and medical imaging...) are based on gathering, in laboratories or within national and international collaborations, a great diversity of skills and knowledge such as:

- Knowledge about fundamental theoretical and experimental physics;
- A broad view of the discipline: currently accepted theories, major open questions and plans to address them...
- Excellent knowledge of practical tools for modeling and analysis (mathematics, statistics, signal processing, database management, numerical simulations, instrumental developments);
- Ease with high-level experimental techniques;
- Teamwork and communication skills (project management, English, report writing, oral presentations).

The main objective of the Master of Physics is to train candidates to fit effectively into this framework, providing them with sound theoretical and practical bases, and giving them the opportunity to start specializing gradually through courses, personal projects and internships. The training aims to provide students with the necessary skills to carry out research and / or development work by focusing on:

- Autonomy in the analysis of a complex problem and the proposal of approaches (theoretical, numerical and / or experimental);
- Solid skills in computing (especially for the analysis of large datasets);
- Collaborative work;
- Ability to communicate scientific results.

The Master of Physics is a research-driven training, leading to fundamental or applied research, work in the *Science, Technology, Engineering and Mathematics* -STEM- industry (especially high-tech) and trades of education or dissemination of science. From a professional point of view, the training prepares either for a career as a researcher or a research engineer in the disciplinary fields concerned, or for a career in a sector where the knowledge and / or skills acquired as physicists prove to be useful. Thanks to a long-standing partnership with [Télécom Physique Strasbourg](#), the Master's degree also assumes the role of contributing to the formation of young engineers. In parallel with research-focused objectives, the Master of Physics also prepares students to pass the French recruitment competition for teachers Agrégation de Physique-Chimie, Option Physique through a specific track PA (Préparation à l'Agrégation). The mastery of the disciplinary foundations of Physics and Chemistry give rise to a solid theoretical and practical professional training in the trades of the education.

The Master of Physics consists of **7 tracks** with of a common first M1 year followed by a specialization at the M2 level. The content of each course is described in the specific pages. The courses are taught in English during the two years. For the main lectures, tutorial classes are duplicated with French and English teaching languages. M1 training consists of a common core of general physics taught through courses and tutorials in the first and second semester. Experimental training is an important part of the curriculum, with projects hosted by local laboratories. During these two semesters, optional courses allow students to discover the different possible tracks and specializations. The ties with ongoing academic research are ensured by weekly seminars given by researchers from Strasbourg laboratories during the first semester. In addition, students will train to actual research work via supervised projects and research internships in physics laboratories through (both in M1 and M2).

#### Résumé français:

Le master Physique de l'Université de Strasbourg est porté par la Faculté de Physique et Ingénierie, en partenariat avec [l'Observatoire d'Astrophysique de Strasbourg \(ObAS\)](#), [Télécom Physique Strasbourg \(TPS\)](#) et [l'École supérieure de biotechnologie de](#)

Composantes	<ul style="list-style-type: none"> <li>• <a href="#">Faculté de physique et ingénierie</a></li> <li>• <a href="#">Observatoire astronomique</a></li> </ul>
Langues d'enseignement	<ul style="list-style-type: none"> <li>• Anglais</li> </ul>
Niveau d'entrée	BAC +3
Durée	2 ans
ECTS	120
Volume global d'heures	750
Formation à distance	Non, uniquement en présentiel
Régime d'études	<ul style="list-style-type: none"> <li>• FI (Formation initiale)</li> </ul>
Niveau RNCP	Niveau 7
Disciplines	<ul style="list-style-type: none"> <li>• Astronomie, astrophysique</li> <li>• Physique - Constituants élémentaires</li> <li>• Physique - Milieux dilués et optique</li> </ul>
Lieu	Strasbourg
Campus	<ul style="list-style-type: none"> <li>• Campus Esplanade</li> </ul>
Secteurs d'activité	<ul style="list-style-type: none"> <li>• <a href="#">Recherche-développement en sciences physiques et naturelles</a></li> <li>• <a href="#">Recherche-développement scientifique</a></li> <li>• <a href="#">Enseignement supérieur et post-secondaire non supérieur</a></li> </ul>
Code ROME	<ul style="list-style-type: none"> <li>• <a href="#">Ingénieur / Ingénieure de recherche scientifique</a></li> <li>• <a href="#">Professeur / Professeure des universités</a></li> <li>• <a href="#">Développeur / Développeuse informatique</a></li> <li>• <a href="#">Expert / Experte systèmes et réseaux informatiques</a></li> </ul>
Stage	Obligatoire
Stage à l'étranger	Possible
Alternance	Non

#### Droits de scolarité

- To know about the registration fees, [check the dedicated page on the site of the University of Strasbourg](#)

Strasbourg (ESBS) et avec les *Instituts Thématiques Interdisciplinaires* ITI/EUR HiFunMat, IRMIA++ et QMat. Après une première année de formation généraliste fortement mutualisée, il propose 6 parcours orientés vers la recherche -Astrophysics and data science (Astro); Physics of Quantum and Soft Condensed Matter (PhyQS); Cell physics; Radiation physics, detector, instrumentation and imaging (PRIDI); Subatomic and astroparticle physics (SAP) and Quantum Technologies-European Program -s'appuyant sur les laboratoires Strasbourgeois et un parcours permettant de préparer le concours de recrutement de l'Agrégation de Physique-Chimie-Option Physique.

## Objectifs

### English version

The aim is to train people to modern astrophysics, and enable students to tackling the discipline's open questions, based on a solid knowledge of the physics of the objects of the Universe, and to make skilful use of modern modern technological tools.

**Key themes:** stars, galaxies, compact objects, interstellar medium, cosmology, physical states and mechanisms, high energies, observation, modeling, numerical simulation, statistics, artificial intelligence, databases, virtual observatories.

### Version française

L'objectif est de former par et pour l'astrophysique moderne des personnes autonomes, capables d'appréhender les questions ouvertes de la discipline en s'appuyant sur des connaissances solides de la physique connue des objets de l'Univers, et d'utiliser avec adresse les outils technologiques modernes du chercheur.

**Thématiques phares :** astres, galaxies, objets compacts, milieux interstellaires, cosmologie, états et mécanismes physiques, hautes énergies, observation, modélisation, simulation numérique, statistiques, intelligence artificielle, bases de données, observatoires virtuels.

- Pour connaître les droits de scolarité, consultez la page dédiée [sur le site de l'Université de Strasbourg](#).

### Contacts

#### Responsable(s) de parcours

- [Pierre Maggi](#)

#### Responsable(s) de mention

- [Thierry Charitat](#)

#### Membres de l'équipe pédagogique

- [Pierre Ocvirk](#)
- [Ariane Lançon](#)
- [Dominique Aubert](#)
- [Gilles Landais](#)
- [Sébastien Derrière](#)
- [Patrick Guillout](#)
- [Jérôme Petri](#)
- [Hubert Baty](#)
- [Mireille Louys](#)

This program intends to build a broad knowledge of the field of astrophysics and its associated methodology to prepare the students to pursue a PhD training in astrophysics or associated domains. It offers during the first semester a set of compulsory courses covering most of the requirements in modern astrophysics as well as courses focused on data science (databases, statistical modeling, etc) with the aim to give the students a strong knowledge base. These courses are complemented by optional courses giving in-depth knowledge on specific topics and permitting students to start building an area of expertise. The second term is devoted to projects and contains observational projects on the in-house telescope, a 5 nights project at a professional observing site (OHP) and a 15 weeks internship. **All the teaching is conducted in English to prepare the students to work in a highly international environment.**

## Métiers visés

### After a PhD

- Astronome
- Academic researcher /Enseignant-chercheur ou chercheur
- Research engineer / Ingénieur de recherche

### With the master of science degree/ avec le diplôme de master

- Teacher/ Métiers de l'enseignement ;
- Outreach and popular science dissemination/ Diffusion des connaissances et journalisme scientifique ;
- Employment in the sector of numerical modeling and image processing / Métiers de la modélisation numérique (toutes disciplines) ou du traitement de l'image ;
- Computer science expertise and development / Conseiller ou développeur informatique .
- Planetarium animation and trade of equipment for skywatchers / Planétariums et matériels pour astronomes amateurs

Pour connaître en détail l'insertion professionnelle de nos diplômés, consultez [cette page](#).

## Candidater

- Find out the information relative to [admission and registration on the site of the University of Strasbourg](#)
- Pour connaître les modalités de candidature, consultez [la page dédiée](#) sur le site de l'Université de Strasbourg.

## Prérequis obligatoires

### English version:

- A 4-year training (M1 level) in physics, mathematics, and computer science is required.
- The teaching is fully in English.
- Direct admission in M2 is possible for outstanding candidates.

**Version française:**

- Une formation de 4 ans (niveau M1) en physique, mathématique, et informatique est requise
- L'enseignement est conduit en anglais uniquement.
- Possibilité d'admission directe en M2 sur dossier (niveau M1 requis).

**Stage****Stage en France**

Durée du stage : at least 15 weeks / 15 semaines minimum

Période du stage : february to june

**Stage à l'étranger**

Durée du stage : at least 15 weeks / 15 semaines minimum

Période du stage : february to june

# Programme des enseignements

## Astrophysics and Data Science

### Master 1 - Physique - Astrophysics and Data Science

Master 1 - Physique - Physics research - Tronc commun

Semester 1 - Physics research				
	CM	TD	TP	CI
UE 1 - Semestre 1 - Quantum mechanics and statistical mechanics	9 ECTS	-	-	-
Quantum mechanics	26h	26h	-	-
Statistical mechanics	26h	26h	-	-
UE 2 - Semestre 1 - Numerical physics and Current research in physics	6 ECTS	-	-	-
Numerical physics	16h	-	16h	-
Current research in physics	14h	-	-	-
UE 3 - Semestre 1 - Experimental physics I	6 ECTS	-	-	-
Experimental physics I	-	-	56h	-
UE 4 - Semestre 1 - Elective course (2 to choose among)	6 ECTS	-	-	-
Liste UE 4 - choisir 2 parmi 10				
Mécanique des milieux continus	26h	-	-	-
Astrophysical objects and their observations	26h	-	-	-
Group theory	26h	-	-	-
Ionizing radiation and detection methods	26h	-	-	-
General relativity	26h	-	-	-
Advanced quantum mechanics	26h	-	-	-
Project	26h	-	-	-
Photonics for quantum science and technology	26h	-	-	-
Soft condensed matter	26h	-	-	-
Focus : sciences physiques ou mathématiques	20h	-	-	-
UE 5 - Semestre 1 - Free course	3 ECTS	-	-	-

	CM	TD	TP	CI
<b>Liste UE 5 - choisir 1 parmi 9</b>				
Mécanique des milieux continus	26h	-	-	-
Astrophysical objects and their observations	26h	-	-	-
Group theory	26h	-	-	-
Ionizing radiation and detection methods	26h	-	-	-
General relativity	26h	-	-	-
Advanced quantum mechanics	26h	-	-	-
Project	26h	-	-	-
Photonics for quantum science and technology	26h	-	-	-
Soft condensed matter	26h	-	-	-
<b>UE facultative (au-delà de 30 ECTS validés) - Bases de mécanique quantique et physique statistique TEST</b>				
Bases de mécanique quantique	16h	-	-	-
Bases de physique statistique	16h	-	-	-

<b>Semester 2 - Physics research</b>				
	CM	TD	TP	CI
<b>UE 1 - Semestre 2 - Nuclear physics and elementary particles 6 Solid state physics 9 ECTS</b>				
Nuclear physics and elementary particles	26h	26h	-	-
Solid State physics	26h	26h	-	-
<b>UE 2 - Semestre 2 - Numerical simulations 3 ECTS</b>				
Numerical simulations	12h	-	16h	-
<b>UE 3 - Semestre 2 - Experimental physics II and Laboratory internship 12 ECTS</b>				
Experimental physics II (in laboratory)	4h	-	16h	-
Laboratory internship	-	-	-	-
<b>UE 4 - Semestre 2 - Elective course (1 to choose among) 3 ECTS</b>				
<b>Liste UE 4 - choisir 1 parmi 9</b>				
Particles and astroparticles	26h	-	-	-
Stellar physics	26h	-	-	-
Atomic and molecular physics	26h	-	-	-
Introduction to physics of living systems	26h	-	-	-
Relativistic quantum mechanics	26h	-	-	-
Numerical methods in physics	26h	-	-	-
Project	26h	-	-	-
Electronics for quantum science and technology	26h	-	-	-
Phénomènes critiques et physique statistique hors-équilibre	26h	-	-	-
<b>UE 5 - Semestre 2 - Free course 3 ECTS</b>				

	CM	TD	TP	CI
<b>Liste UE 5 - choisir 1 parmi 9</b>				
Particles and astroparticles	26h	-	-	-
Stellar physics	26h	-	-	-
Atomic and molecular physics	26h	-	-	-
Introduction to physics of living systems	26h	-	-	-
Relativistic quantum mechanics	26h	-	-	-
Numerical methods in physics	26h	-	-	-
Project	26h	-	-	-
Electronics for quantum science and technology	26h	-	-	-
Phénomènes critiques et physique statistique hors-équilibre	26h	-	-	-
<b>Liste UE facultative Facultatif</b>				
UE 7 - Semestre 2 - Optional	-	-	-	-
Voluntary internship	-	-	-	-

## Master 2 - Physique - Astrophysics and Data Science

<b>Semester 3</b>				
	CM	TD	TP	CI
UE 1 - Semestre 3 - Astrophysical objects and theories	12 ECTS	-	-	-
Introduction to astrophysics	12h	-	-	-
Cosmology	16h	-	-	-
Galaxies	18h	2h	2h	-
Stellar Physics	16h	-	-	-
Interstellar Medium	8h	2h	-	-
UE 2 - Semestre 3 - Data analysis	6 ECTS	-	-	-
Statistics, Inference and Machine Learning	20h	-	-	-
Databases	8h	-	12h	-
UE 3 - Semestre 3 - Numerical physics and astrophysical medium modeling	6 ECTS	-	-	-
Introduction to programming	-	26h	-	-
Plasmas and MHD	18h	2h	-	-
Numerical methods and simulations	4h	-	26h	-
UE 4 - Semestre 3 - Option (1 to choose among)	3 ECTS	-	-	-
<b>Liste UE 4 - choisir 1 parmi 4</b>				
Inverse problem theory and advanced data analysis	20h	-	-	-
High Energy Astrophysics	20h	-	-	-
Galaxy evolution	20h	-	-	-
External (planetary science, telescope and instrumentation, solar physics)	20h	-	-	-

	CM	TD	TP	CI
UE 5 - Semestre 3 - Option (1 to choose among) 3 ECTS	-	-	-	-
<b>Liste UE 5 - choisir 1 parmi 4</b>				
Inverse problem theory and advanced data analysis	20h	-	-	-
High Energy Astrophysics	20h	-	-	-
Galaxy evolution	20h	-	-	-
External (planetary science, telescope and instrumentation, solar physics)	20h	-	-	-
UE 6 - Semestre 3 - Option (1 to choose among) 3 ECTS	-	-	-	-
<b>Liste UE 6 - choisir 1 parmi 4</b>				
Inverse problem theory and advanced data analysis	20h	-	-	-
High Energy Astrophysics	20h	-	-	-
Galaxy evolution	20h	-	-	-
External (planetary science, telescope and instrumentation, solar physics)	20h	-	-	-

<b>Semester 4</b>				
	CM	TD	TP	CI
UE 1 - Semestre 4 - Bibliographical and observationnal projects 6 ECTS	-	-	-	-
Observation mission at Observatoire de Haute Provence	4h	-	40h	-
Observation project at 2T36 telescope	-	4h	-	-
UE 2 - Semestre 4 - Professional integration 3 ECTS	-	-	-	-
Seminars, professional forum, and Internship host institute projects	2h	2h	2h	-
UE 3 - Semestre 4 - Internship 21 ECTS	-	-	-	-
Internship	-	-	-	-
<b>Facultatif Facultatif</b>				
Optional	-	-	-	-
Voluntary internship	-	-	-	-