



PhD in Astrophysics Study Plan

Facultad de Ingeniería y Ciencias

Version 2025

I. General Information

Name :	Doctorado en Astrofísica
Code	DAF01.1_2024
Faculty	Facultad de Ingeniería y Ciencias
Degree:	Doctor en Astrofísica
Intermediate degree:	Magíster en Astrofísica
Director:	Paula Jofré
Year of creation:	2018
Year of first admission:	2019
Duration:	8 semesters
Dedication:	Full time
Working hours:	Day-time
Modality:	In person
Credits:	240

Academic committee (2025):

Paula Jofré (PhD director)
Evelyn Johnston (PhD Coordinator)
Jose Luis Prieto (IEA director)
Alice Zurlo

Faculty:

Area Planetary Systems: James Jenkins, Alice Zurlo, Bin Yang, Lucas Cieza.
Area Stellar and Galactic Astronomy: Paula Jofré, José Luis Prieto, Evelyn Johnston, James Jenkins
Area Extragalactic Astrophysics: Roberto Assef, Manuel Aravena, Chiara Mazzucchelli, Lorena Hernández (starting 2025-B), Enrique Paillas (starting 2026)

Collaborators:

Thomas Maedler (UDP), Nayat Sanchez-Pi (Inria-Chile), Luis Martí (Inria-Chile), Leopoldo Infante (LCO), Roberto Lavin (UDP).

II. DESCRIPTION.

2.1. *Foundation*

The Núcleo de Astronomía UDP (Astronomy Nucleus in English) was created in 2013 with the intention of forming an international and competitive research group which could take advantage of the enormous advantages for astronomical research in Chile. Currently, Chile hosts the largest collection of telescopes in the world, and its position is only getting better. With ELT, GMT and LSST, Chile will have 70% of the world's astronomical infrastructure. This offers a unique opportunity for Chilean universities to compete successfully for the 10% of observing time reserved for the country. During the first decade, the Núcleo de Astronomía managed to establish as one the most research productive astronomy groups in Chile. In 2023, it was officially renamed the Instituto de Estudios Astrofísicos (IEA, or the Institute of Astrophysical Studies in English). In this context, the creation of a PhD program was crucial for making UDP a research institution with international reputation. This considers that:

- 1) The formation of new researchers is the responsibility of established researchers and of universities that pursue high impact research.
- 2) The PhD program at UDP is a valuable contribution to the astronomical development in Chile, offering a wider range of postgraduate opportunities in the country.
- 3) Supervising PhD theses is a fundamental aspect in the career of a scientist, especially astronomers. Therefore, a PhD program is necessary to attract and retain international-level astronomers at UDP.
- 4) PhD programs of high quality offer prestige to their corresponding university, improving the quality of its students and spreading the impact when graduates leave the university.

2.2. *Research lines*

- 1) **Planetary Systems:** planet formation, protoplanetary disks, extrasolar planets, cosmic dust laboratory, solar system.
- 2) **Stellar and Galactic Astronomy:** stellar evolution, stellar populations and chemical abundances, galactic dynamics, galactic archaeology, supernovae and other stellar explosions, transients, compact objects.
- 3) **Extragalactic Astronomy:** galactic evolution across cosmic time, active galactic nuclei (AGN), supermassive black holes, cosmology, and the Large-scale structure of the Universe.

2.3. For whom is the PhD program designed

The program is designed for applicants that already have a bachelor's or a master's degree in astronomy or related fields (physics, planetary sciences, etc). It is expected that applicants have excellent grades in their previous studies, have some experience with research and are highly motivated to pursue research in astronomy. Applicants must know English (reading in English is essential and writing/speaking in English is highly encouraged) and must be able to dedicate their full time to the PhD program.

2.4. Admission requirements and criteria for selection

The formal requirements are: bachelor's or master's degree in astronomy or related areas (physics, planetary sciences, etc). In addition, the motivation and ability to do a PhD will be evaluated considering:

- 1) Cover letter expressing the motivation to do a PhD, listing research interests.
- 2) CV
- 3) Transcript of previous grades (bachelor's/master's), if they are available
- 4) Certificate from university specifying when degree will be obtained if not available at the moment of the application
- 5) 2-3 letters of recommendation.

Applicants will be ranked and selected for an interview with members of the academic committee and the faculty. The ranking is based on the following criteria:

- Previous education, ranking, grades and level of English (40%)
- Previous experience in research and CV (20%)
- Motivation to obtain a PhD based on the cover letter (20%)
- Potential to succeed in the program based on the recommendation letters (20%)

Even though these criteria will be used to short list candidates, every application will be discussed individually based on more aspects:

- Exceptional candidates whose level of English is deficient will be considered.
- Balance of research areas will be prioritized. Supervisors with no students will have priority over supervisors with several students.
- The selection of new students will aim to achieve gender balance and benefit under-represented groups.

2.5. Program objectives

- 1) Contribute to the training of researchers in astrophysics, one of the areas that Chile has the potential to become a world-class leader.

- 2) To build a highly productive research group, with outstanding students and postdocs, who contribute to the research areas of the IEA: Planetary Systems, Stellar and Galactic Astronomy, and Extragalactic Astrophysics.
- 3) Contribute to the training of professionals in the areas of physical sciences and technology, which can be transferred to related fields such as data analysis, observatory roles, education, communication and outreach.

2.6. Our graduates

A doctor in astrophysics from UDP will be able to pursue original and independent research, contributing to their discipline through publications and conferences.

They will have the ability to apply and integrate their knowledge about astrophysics as well as their methods and tools (such as observing techniques, data analysis, method analysis, numerical simulations, etc), to work on cutting-edge science in their discipline.

Furthermore, they will have developed critical thinking and skills to work in collaborations. That will allow them to be inserted in international research networks and contribute to various competitive academic and professional environments. Graduates will be able to work in purely academic environments, such as universities, or more technical ones, such as observatories. Likewise, their critical thinking and technological skills could be transferred to the private sector which benefits from data science, or the education and outreach sector.

2.7. Curriculum

The program has two cycles, the initial and the final one — divided by the Qualification Exam. The program ends with the PhD defense.

The initial cycle has a duration of 3 semesters, and it is based on a program that mixes courses and research projects. The cycle finishes with a successful qualification exam, based on a thesis proposal which has to be defended by the student. Thus, the initial cycle, along with the courses, are meant to provide the student with a deep knowledge of their chosen discipline, as well as an overview of how their discipline fits in a wider astronomical context. Research projects are meant to teach the initial methodologies, which will be developed throughout the thesis. The thesis project is proposed by the student, with the help of their supervisor.

The final cycle has a duration of 5 semesters, and it is based on the thesis project research only. It finishes at the 8th semester of the program, with a PhD defense.

All students are expected to participate and engage in colloquia, journal clubs, and oral presentations of their research during the entire program. Students with preliminary results are furthermore encouraged to present them at conferences. Students are also expected

ted to proactively look for opportunities to complement their formation with workshops, schools or courses organized outside UDP. All these activities are key opportunities to be informed about the state-of-the-art in astronomy, to network, and to organize their own research project in a wider context.

The Chilean system can be seen like a video game: each student accumulates “credits” as they pass from one semester to the next. There is a minimum number of credits that are needed for the qualification exam, as well as for the PhD defense. When students pass a course, they obtain the credits.

Initial cycle			
1° semester	2° semester	3° semester	
Academic leveling course: General astrophysics* (5 credits)			Qualification exam
Topics of Astrophysics I (6 credits)	Topics of Astrophysics II (6 credits)	Topics of Astrophysics III (6 credits)	
Course 1 (Core, general, or specialization)** (8 credits)	Course 2 (Core, general, or specialization)** (8 credits)	Course 3 (Core, general, or specialization)** (8 credits)	
Research project I (16 credits)	Research project II (16 credits)	Thesis project (16 credits)	

* The Academic leveling course has to be approved. It is offered as an intensive crash-course in January.

** At least one of these courses needs to be the core of the area in which the student is developing their thesis project: **DAF0030 - Stellar and galactic astronomy**; **DAF0004 - Planetary systems**; **DAF0007 - Extragalactic astrophysics**.

Final cycle					
4° semester	5° semester	6° semester	7° semester	8° semester	Thesis Defense
Thesis I (30 credits)	Thesis II (30 credits)	Thesis III (30 credits)	Thesis IV (30 credits)	Thesis V (30 credits)	

Initial cycle

The PhD program at UDP has a strong emphasis on research and it is expected that students identify their research areas and PhD advisors during the first two semesters. In case the thesis advisor is identified at the start of the program, it is expected that the student will take the courses Research Project I and II with the advisor. In case the student has not identified their advisor, the director of the program will assign a guiding professor who will discuss with the student and the Academic Committee until the student finds their advisor. The guiding professor will help the student to choose a supervisor for the courses Research project I and II, as well as the courses, until the student chooses their advisor — with whom the student will take the Thesis project course in the third semester.

The initial cycle is designed to offer a comprehensive education and training in astrophysics, and as such, every student will make their own study plan with the help of their supervisor or guiding professor. This will help to establish which courses will be chosen for the initial cycle. The courses are intended to provide complementary knowledge to the research projects. There are three kinds of courses:

- **Core courses:** one of each area of the PhD program, namely: Stellar and galactic astrophysics, Planetary systems, Extragalactic astrophysics. One core course is offered each semester, and they rotate, ensuring that every student will have the opportunity to take the course of their area during the initial cycle.
- **Specialization courses:** Specialized courses in a specific area, such as solar system (planetary area), stellar spectroscopy (stellar and galactic area), transients (stellar and galactic area), AGN (extragalactic area).
- **General courses:** these courses are useful for all areas, such as radiative process, observing techniques, machine learning, bayesian statistics, etc.

Students can choose among these courses, but must take the core course of their area. Each professor will have their own strategy and criteria to evaluate the courses.

Students that have a master's have the possibility to transfer credits in a semester, if similar courses were taken in their previous degree. This implies the initial cycle is shortened by one semester, i.e., presenting the thesis project and taking the qualification exam after the second semester, and finishing the PhD in 7 semesters instead of 8.

In addition, the Program offers annually the academic leveling course **General Astrophysics**, which is for students that have a different education than astrophysics, or for students that are lacking some fundamental knowledge that is negatively impacting their research development. The academic committee and the supervisor will evaluate the students using the feedback and the overall progress to assess if a student will benefit from such a course. If that is the case, the academic committee will recommend the student to be enrolled in the summer crash course, prior to the qualification exam. That course has to be approved, regardless of the number of credits the student might have accumulated, in order

to present the thesis project for the qualification exam. This course does not replace another course of the initial cycle.

The Research Projects I and II allow the students to familiarize themselves with the various dimensions of research: literature and state-of-the-art, identification of open questions and methods to answer them, observing proposals, techniques and tools to do data analysis, critical discussions of results, and presentations of results orally (talks) and in written form (publications). It is expected that the Research Projects I and II help the student in defining their thesis project. The evaluation will be based on a written report about the various research activities, and an oral presentation through the “Research Jamboree”, to be carried out at the start of the following semester.

The course Topics of Astrophysics I, II and II will give a broad overview of the state-of-the-art in astronomy based on literature discussion and seminars from various experts in astronomy that are either based at UDP or international institutions. These courses help students to put their discipline in wider context, to develop presentation skills, and to network with speakers. The evaluation will be based on presentations of the students, their discussions during the sessions and written reports about the colloquia organized by the IEA.

The Thesis project is a research project but directed to develop the Thesis work. Under the guidance of the advisor, the research project will finish with a Thesis proposal and the qualification exam. It needs to be written in English and must include:

- a) An Abstract
- b) Definition of the problem, hypothesis and questions to be addressed.
- c) Critical literature review, explaining the theoretical context and the state-of-the-art.
- d) Research methodology
- e) Plan of activities, specifying milestones such as data collection and publications.

The Thesis project evaluation will be based on the written report and an oral defense. After the exam, the Thesis committee will decide in simple majority if the student passes or fails. In case of failing, there is a second opportunity to take the qualification exam again in 6 months, only if the student has not failed any course before. If the student fails the second attempt, they will be eliminated from the program. In case of passing, the student becomes a “PhD candidate” and passes to the final cycle of the PhD program.

Final Cycle

The final cycle has 5 semesters and it is focused on thesis work, finishing with the thesis defense. The work is mostly autonomous, but allows for regular meetings with the advisor as part of the courses Thesis I, II, III, IV and V. The courses are evaluated during the oral presentations every semester, and through the feedback from the supervisor to the student.

At least once a year, the student will meet with the Defense Committee, submitting a written report which states the progress of the thesis work. These reports will be shared with the committee to allow for an evaluation of the progress and for feedback and suggestions. It is furthermore expected that in this cycle the student enlarges their network by engaging in internships and presenting results at conferences.

The PhD thesis must be a research work that is original and contributes to the discipline. It is expected that the work is equivalent to two refereed publications. At least one of these papers must be published or accepted by a WoS journal at the time of the PhD submission, and a second paper must be in an advanced stage to be submitted shortly after the defense. Both papers need to be related to each other and be consistent with the introduction and the overall field of research. The Thesis must include a section of general conclusions.

The Thesis will be evaluated by a Committee which will have 5 members (advisor included), all with PhD degree and experts in topics related to the thesis. The committee has to be assembled within the 3 months immediately after the qualification exam and will be available to meet at least once a year with the student, to evaluate the progress. The thesis and the defense will be in English.

2.8. Requirements for graduation and final grade ***

The requirements for graduation are:

- a. To have passed (or have transferred credits) all courses.
- b. To have passed the qualification exam.
- c. To have submitted a written thesis and have given an oral presentation.

The final grade will consider:

- 50% Written manuscript (*DAFINFTE1*)
- 50% Oral defense (*DAFINFTE1*)

*** New regulations for defenses have been implemented at UDP which we need to follow, meaning that the process for defenses is currently going through a change.

2.9. Masters in astrophysics

Students can choose an intermediate degree - Masters in Astrophysics, once they have finished the initial cycle and the student does not wish to continue to the final cycle. In order to obtain this degree, the student needs to fulfill the following requirements:

1. Pass all activities in the initial cycle, except the qualification exam. That is, to have accumulated the 90 credits of the initial cycle.
2. To present a Masters thesis (in English) based on the research done during the initial cycle.

3. Pass the masters oral defense, also in English.

The masters thesis must be a research project that is original and contributes to the discipline, the work must be equivalent to a scientific publication in WoS, and that shows that the student has the ability to pursue a scientific work in the area of astrophysics. The masters thesis must include an introduction with a theoretical background and another section with general conclusions.

The manuscript and its oral defense will be evaluated by the masters thesis committee which will be the same committee as the qualification exam, unless justified. Each member will assign an assessment (pass, fail) to the written and the oral exam (each 50%).

In case of failure, the student can defend their masters thesis again within the next 3 months.