Universidad Zaragoza

Academic Year/course: 2021/22

68350 - Frontier topics in cosmology, astrophysics and particle physics

Syllabus Information

Academic Year: 2021/22
Subject: 68350 - Frontier topics in cosmology, astrophysics and particle physics
Faculty / School: 100 - Facultad de Ciencias
Degree: 628 -
ECTS: 6.0
Year: 01
Semester: Annual
Subject Type: Compulsory
Module:

1. General information

1.1. Aims of the course

The aim of the course is to provide the student with a set of essential knowledge to approach the field of research in the lines proposed by the Master. This course will bring the student closer to leading research fields at present in the hands of renowned experts in cosmology, astrophysics, particle physics and astroparticle physics. He/She will also carry out short stays in two singular scientific facilities such as the Canfranc Underground Laboratory (LSC) and the Cosmos Physics Study Center of Aragon (CEFCA).

1.2. Context and importance of this course in the degree

It is one of the two compulsory subjects. It has been conceived to give an overview of the frontiers of research in Cosmology, Astrophysics and Particle Physics. The format of the course will be a series of topics taught by different professors who will offer a current vision of research in Cosmology, Astrophysics and Particle Physics. There will also be seminars given by researchers from national or foreign centers who will contribute their experience and with which it will be possible to debate in person or through a forum. On the other hand, students will have to deepen through a guided project on a topic of their choice. The course also includes a short stay both at the Canfranc Underground Laboratory (LSC) and at the Cosmos Physics Studies Center of Aragon (CEFCA) for participation in research activities.

1.3. Recommendations to take this course

Due to its format, there are no special recommendations for taking this course.

2. Learning goals

2.1. Competences

After the course, the student will be more competent to:

- Start a Doctoral Thesis in the fields of Cosmology, Astrophysics, Particles and Astroparticles
- Delve into a research topic and learn about the most recent advances and current lines of research in the fields of Cosmology, Astrophysics, Particles and Astroparticles
- Participate in experiments or observations carried out at LSC or CEFCA.

2.2. Learning goals

To pass this course, the student needs demonstrate the following results:

- Know the leading lines of research in cosmology, astrophysics, particle physics and astroparticles.
- Know the large centers and facilities where this type of research is carried out.
- Delve into the evolution of the universe.
- Delve into the Standard Model of particle physics, extensions, and theories beyond this model.
- Delve into Cosmology and Gravitation.

- Delve into dark matter and energy.
- Delve into cosmic multi-messengers.
- Have contact and be able to debate with experts in this type of research.
- Have an overview of the different research methodologies.
- Get started in the dissemination of subjects related to the title.

2.3. Importance of learning goals

Cosmology, Astrophysics, Particle Physics and Astroparticle Physics are leading research disciplines at the moment. They are the basis for understanding the Universe, its smallest constituents and their interrelationships. Progress in these disciplines has increased their deep interconnections and suggests synergy between specialists and the encouragement of cross-sectional research profiles that allow addressing the aforementioned challenges. Aragon has leading researchers, scientific groups of excellence, and unique facilities in the field of Cosmology, Astrophysics, Astronomy, Astroparticles and Particle Physics, known internationally. The Center for Astroparticles and High Energy Physics (CAPA) is a common framework for this type of research and specialized training, which is joined by the Canfranc Underground Laboratory (LSC), and the Cosmos Physics Studies Center of Aragon (CEFCA). This subject will allow students to acquire a global and updated perspective of the research carried out in these disciplines, with a special focus on the aforementioned research centers.

3. Assessment (1st and 2nd call)

3.1. Assessment tasks (description of tasks, marking system and assessment criteria)

The student has to demonstrate that he/she has achieved the expected learning outcomes through the following assessment activities:

- Reports and written works: 40%
- Oral presentations of works: 20%
- Exam tests: 30%
- Participation in debates or discussion forum: 5%
- Participation in outreach activities: 5%

The final mark will be obtained according to the above percentages. To pass the subject the final mark must no lower than 5.0.

A single global test

The course has been designed for students who attend face-to-face classes in the classroom, and carry out the evaluation activities described above. However, there will also be an evaluation test for those students who have not carried out the evaluation activities or have not passed them.

This global test will be carried out on the dates established by the Faculty of Sciences and will consist of an evaluation of the same learning results as in the continuous evaluation tests.

Honors degree qualification

The honors degree will be awarded to students who achieve the maximum grades, as long as it is above 9.0.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The learning process that has been designed for this course is based on the following activities:

- Master classes
- Visits to laboratories, observatories and research centers
- Oral presentations
- Written works
- Seminars
- Tutorial classes
- Work and personal study
- Assessment test

4.2. Learning tasks

The program offered to the student to help him achieve the expected results includes the following learning tasks:

1. Participation and attendance at lectures, 24 hours

2. Participation and attendance at seminars given by experts, 6 hours
3. Deepening of topics related to the contents of the title, 24 hours
4. Visits to laboratories, observatories and research centers, 24 hours
5. Development of guided projects, 15 hours, of which 1.5 face-to-face
6. Tutorials in person or online, 2 hours, of which 1 face-to-face
7. Individual study, 36 hours
8. Written or oral evaluation tests, 6 hours, of which 3 in person.
9. Outreach activities, 5 hours
10. Debates in discussion forum, 8 hours.

4.3. Syllabus

Six topics, which may vary, depending on the status of the investigations. Some current examples:

- Evolution of the Universe
- Black holes and Gravitational waves
- Exoplanets and exo-Earths
- Simulation techniques in Astrophysics
- Test of the Standard Model and beyond in particle accelerators
- Dark Matter Candidates. Detection
- Cosmic multi-messengers
- The mass of the neutrino
- Particle physics on the lattice
- Large facilities for particle physics and astrophysics

4.4. Course planning and calendar

Calendar of in teaching sessions and assessments

The dates will be established and announced by the teachers at the beginning of the course.

Classes will begin and end on the dates indicated by the Faculty of Sciences.

- Theory classes: 5 sessions per week during the 6 weeks marked on calendar.
- Visits to research centers: will be announced by the teachers at the beginning of the course.
- Assessment sessions: dates to be decided.