60034 - Particle physics

Información del Plan Docente

Academic Year	2017/18
Faculty / School	100 - Facultad de Ciencias
Degree	538 - Master's in Physics and Physical Technologies
ECTS	5.0
Year	1
Semester	Second semester
Subject Type	Optional
Module	---

1.General information

1.1.Introduction

1.2.Recommendations to take this course

1.3.Context and importance of this course in the degree

1.4.Activities and key dates

2.Learning goals

2.1.Learning goals

2.2.Importance of learning goals

3.Aims of the course and competences

3.1.Aims of the course

The aim of this course is to present the application of modern theoretical physics methods to the realm of elementary particle physics. It is recommended for students who have a previous background knowledge in Quantum Physics and High Energy Physics. Other courses of the Master complementary to the present one are "Relativistic Astrophysics, Astroparticles and Cosmology", "Interaction of Radiation and Matter", and "Quantum Theory of Condensed Matter".

The current development of our understanding of the Universe is at present in a golden age given the recent start of the Large Hadron Collider (LHC), the world's largest and highest-energy particle accelerator. It is a particle accelerator used by physicists to study the smallest known particles - the fundamental building blocks of all things. It will revolutionize our understanding, from the minuscule world deep within atoms to the vastness of the Universe. In the course of the last century, physicists ventured into ever smaller dimensions. Today, the Standard Model of particle physics very successfully describes the fundamental building blocks of our world and the forces acting between them. Nevertheless, central questions remain unanswered. Where does the mass come from? What is dark matter made of? What happened during the big bang? Are there any possible extension of the Standard Model?

This course is interesting for all students who on the one hand want to know the current state of our knowledge in microscopic physics and from a methodological point of view it provides a very detailed application of field theoretical methods which can be interesting in many areas of modern physics. At the end of the course the students should understand the main steps that have lead us to the formulation of the standard model and should be able to analyze the consequences of different extensions of the standard model based on the addition of new fields and/or interactions.

Students of theoretical condensed matter physics as well as theoretical high energy physics and also students in phenomenology and experiments in particle physics may find relevant information for their future work in this course. The multidisciplinary nature of this subject makes it especially relevant to the student's training as it requires a deep knowledge of fundamental aspects of particle physics nowadays and the application of different theoretical tools. In addition, this course will enable students to develop a critical and analytical thinking both on open questions in current particle physics and in ways that transcend the academic sphere.

3.2.Competences

4.Assessment (1st and 2nd call)

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

A continuous evaluation will take into account the personal work of the students throughout the course. The evaluation (40% of the final mark) will reflect the quality of the solutions to the proposed exercises and the participation in the course.

The course will also comprise an oral presentation of a project related to one of the topics addressed in the course. 60% of the final mark will be based on the quality of the work done by the students and its oral defense.

The course has been primarily designed for students who are able to attend the lectures on site. However, there will also be an evaluation test for those students who are either unable to attend these lectures or who fail in their first evaluation. The test will consist on filling in a questionnaire related to the subject contents.

The questionnaire will consist of two parts:

1. One part will contain 6 questions related to the main concepts discussed in the course. It will be evaluated from 0 to 10 and the result will amount to 60% of the final mark.
2. A second part in which the student will be asked to solve one among two proposed exercises similar to those developed during the course (40% of the final mark).

5.Methodology, learning tasks, syllabus and resources

5.1.Methodological overview

The methodology followed in this course is oriented towards achievement of the learning objectives. It favors the acquisition of theoretical and phenomenological expertise in the field of particle physics. In order to get these results, we have programmed activities which improve the students' active and continuous implication within the different topics. The course consists of two well separated training activities:

- Lectures include theoretical explanations, problem-solving and discussion (3.5 ECTS).
- Study and presentation of a selected research work in the field (1.5 ECTS).

These activities will allow the student to acquire the desired knowledge on the topics of the course, theoretical and phenomenological skills in particle physics, and problem-solving competences.

5.2.Learning tasks

60034 - Particle physics

The course includes the following learning tasks:

- Lectures include theoretical explanations, problem-solving and discussion (3.5 ECTS).
- Study and presentation of a selected research work in the field (1.5 ECTS).

5.3.Syllabus

The course will address the following topics:

1. Electroweak theory: Interactions. The origin of particle masses. Spontaneous symmetry breaking in physics.
2. Flavour physics: Flavour symmetry and quantum numbers. Conservation laws. Flavour changing neutral currents. The GIM mechanism. Cabibbo-Kobayashi-Maskawa matrix (CKM).
3. Neutrino physics: Masses, mixing and oscillations. Dirac and Majorana fermions. Seesaw mechanism. Neutrino oscillations. Violations of the lepton number conservation laws. Beta and double beta decay.
4. Feynman rules. Observables. Cross section. Decay widths and lifetimes.
5. Particle physics at colliders: Large Hadron Collider (LHC): Higgs discovery, Present and Future. Higgs phenomenology. Heavy ion collisions, CP violation. Experiments in particle physics and applications.
6. Physics beyond the standard Model.

5.4.Course planning and calendar

Further information concerning the timetable, classroom, assessment dates and other details regarding this course, will be provided on the first day of class or please refer to the Faculty of Science http://ciencias.unizar.es/

5.5.Bibliography and recommended resources