Universidad Zaragoza

Academic Year/course: 2022/23

26937 - Gravity and Cosmology

Syllabus Information

Academic Year: 2022/23
Subject: 26937 - Gravity and Cosmology
Faculty / School: 100 - Facultad de Ciencias
Degree: 447 - Degree in Physics
ECTS: 5.0
Year:
Semester: Second semester
Subject Type: Optional
Module:

1. General information

1.1. Aims of the course

In general, the goal of the subject ?Gravitation and Cosmology? is that the student acquires the adequate capabilities of analysis, abstraction and syntheses learning at the same time to express the scientific concepts with the necessary rigour. In parallel, it shall provide the basic mathematical tools for the study and resolution of Einstein?s relativistic equations. Within these general goals, this subject provides with an application of the mathematical tools of differential geometry to the study of gravitational phenomena. The course begins with a study of the physical reasons to demand an extension of the Newtonian formulation of gravity to make it compatible with special relativity. Later Einstein's equations for the gravitational field will be justified and will be solved in two situations: the geometry generated by the Sun and the geometry of the expanding universe. Then we will review our knowledge of the evolution and the geometry of the expanding universe. Finally we will review our knowledge of the evolution of of the universe from the beginnings until today describing the most important epochs and phenomena.

The aims of the course are aligned with the following Sustainable Development Goals (SDGs):

- Goal 4: Quality Education

1.2. Context and importance of this course in the degree

The subject is framed in the optional module of the degree in physics (3rd course) and answers to the necessity to tackle the understanding of gravitation with enough precision to adjust to the cosmological observations and the techniques that derive from such knowledge.

1.3. Recommendations to take this course

It is recommended to attend and participate actively in to the classes and teaching activities like resolution of exercises, homework tutorials, etc.

2. Learning goals

2.1. Competences

Upon passing this course, the student will be more competent for ...
Settling previous knowledge of quantum mechanics, statistical physics and Newtonian gravitation upon its application to the understanding of the universe.
Understanding the observational techniques being currently used, which have allowed huge developments both conceptual and technical in the understanding of the Universe.
Understanding one of the essential theoretical foundations of modern physics, General Relativity, which together with Quantum Mechanics form the basis of our current understanding of the world and thus a central pillar of the scientific heritage of mankind.

2.2. Learning goals

The student, to pass this course, will need showing the following results...
Understanding the physical premises in which the theory of general relativity is based did using the equations of understand

from the principle of general covariance.
Being able to solve the equations of gravitational field in simple cases touched upon throughout the course distinguishing coordinate and physical singularities.
Determinining relativistic corrections to planetary orbit and the comparison with observations.
Analysing the structure and composition of the universe, its history, the kinematical origin of large-scale homogeneity and its recent measurements.
Applying Einstein's equations to the universe as a whole and searching the energetic composition of it the better reproduces the observations.

2.3. Importance of learning goals

Our understanding of the universe is presently in a golden age given the recent observations of the large scale structure that have triggered the era of precision cosmology. Similar observations are planned to improve in the immediate future to yield even more precise results.
The multidisciplinary character of the subject makes it especially relevant for the formation of the student. It requires the application of different theoretical tools and acquaintance with very different observational techniques.

3. Assessment (1st and 2nd call)

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

The student will need to show having reached the foreseen learning goals through the following evaluation activities.
The first 50% of the mark will reflect the results of the day-to-day evaluation of written exercises and essays, oral presentations of exercises or small subjects.
The second 50% of the mark will be given through written exams consisting on solving exercises or multiple tests. Clarity in the exposition, precision of numerical results and, most of all, mastering the basic concepts of the subject will be gently evaluated.
Passing the course through a global exam:
Regardless of the above, the student can pass the course through a global exam consisting on theoretical questions and problems.

4. Methodology, learning tasks, syllabus and resources

4.1. Methodological overview

The methodologies of teaching-learning that is proposed to achieve the planned goals in acquiring the competencies are the following:
Theory masterclasses: blackboard/slides live lectures (three hours per week) in which the fundamental concept of the subject will be explained.
Tutorials: live interactive sessions (1 hour/week) in which the students will be directed/helped in the resolution of proposed practical exercises.
Keynote presentations: sessions in which the students will present the essays that have written and will answer questions about them.

4.2. Learning tasks

Teaching and evaluation activities that will take place in a face-to-face manner, baring exceptional situations dictated by the competent authorities and the University of Zaragoza.
Learning activities of the subject are master classes, tutorials and the elaboration and presentation of essays and exercises.

4.3. Syllabus

Current observations
Newtonian gravity
Description of the theory of general relativity
Geometry of solar system
Movement of planets and light bending
The standard cosmological model
History of the universe
Matter radiation decoupling
Big bang nucleosynthesis
Primordial inflation
The current accelerated expansion
Structure formation
The big bang and quantum gravity

4.4. Course planning and calendar

Master classes and tutorials (intertwined) for 4 hours a week during the months from February to May (around 56 hours in the semester).
Lecture times are defined in the schedule published every year by the Decanato of the Faculty.
The written tests of the continuous evaluation will take place in tutorials time.
Homework essays: during the period of classes the students will hand and present before the teachers the optional essays that might have prepared (approximate load of 18 hours).
The global exam is fixed by the Decanato de la Facultad at the beginning of each course and is published in the official schedule.

4.5. Bibliography and recommended resources

http://psfunizar10.unizar.es/br13/egAsignaturas.php?codigo=26937