# Relativity

## Prof. Roberto Auzzi

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course aims to treat in detail special relativity and to introduce some basic aspects of general relativity, in particular the study of geodesics.

At the end of the course, students will be able to solve problems in relativistic kinematics and dynamics, including particle collisions and will understand the covariant formulation of Maxwell equations. The student will be able to apply the geodesic equation to the problem of the motion of a particle in a gravitational field.

***COURSE CONTENT***

Relativistic kinematics: Lorentz transformations, composition law for velocities, length contraction, time dilatation, spacetime interval, lightcone, proper time

Relativistic dynamics: four-vectors, relativistic momentum and energy, relativistic collisions and decays, Doppler effect

Tensors in special relativity, covariant formulation of electromagnetism, energy-momentum tensor. Lagrangian for a relativistic particle.

Equivalence principle and gravitational redshift. Metrics and curved spacetime. Geodesic equation and Newtonian limit.

Schwarzschild metric for a spherically symmetric gravitational field. Massive particle orbits. Light ray orbits: deflection of light.

***READING LIST***

- T. Cheng, *Relativity,* *Gravitation and Cosmology* (Oxford, 2010).

- J.B. Hartle, *Gravity: an Introduction to Einstein's General Relativity* (Addison-Wesley, 2002).

- L. D. Landau - E. M. Lifshitz, *The classical theory of fields* (Butterworth-Heinemann, 1980).

- S. Weinberg, *Gravitation and Cosmology* (Wiley, 1972).

- A. Zee, *Einstein gravity in a nutshell* (Princeton university press, 2013).

***TEACHING METHOD***

Lectures in classroom.

***ASSESSMENT METHOD AND CRITERIA***

Oral examination. The oral exam intends to evaluate the assimilation of the concepts presented and the ability to reason and analytical rigor on the topics covered by the course. The test consists of three questions in which the candidate will be asked to solve some exercises related to the course program. The evaluation of the oral exam will take into account the correctness of the results, the procedures used to obtain them and the logical and methodological rigor.

***NOTES AND PREREQUISITES***

The student must have basic knowledge of mathematical analysis, linear algebra, newtonian mechanics and electromagnetism. In the second part of the course, some notions of lagrangian mechanics will be used (as treated in the parallel course of Analytical Mechanics).

Prof. Roberto Auzzi receives in the office after the lessons.