# Gravity and Cosmology

## Prof. Roberto Auzzi

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

The course aims to treat general relativity and its applications to cosmology.

At the end of the course, the student will know Einstein equation for the gravitational field and he will be able to apply general relativity to the study of the primordial universe and to black holes. The student will appreciate the relevance of the problem of the cosmological constant and of dark matter in modern cosmology.

***COURSE CONTENT***

Brief summary of special relativity.

Manifolds, metric tensor and geodesics. Tensors in general relativity. Covariant derivative. Riemann and Ricci tensors.

Einstein equation. Lagrangian formulation of general relativity.

Homogeneous and isotropic universe. Hubble’s law. Big bang cosmology. Friedmann-Lemaitre-Robertson-Walker metric. Cosmological redshift. Friedmann equation with multiple components.

Measure of cosmological parameters. The thermal history of the universe. The Cosmic Microwave Background.

The Schwarzschild black hole. The Kruskal coordinates and the wormhole.

Linearised gravity and gravitational waves.

***BIBLIOGRAPHY***

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

- S.M. Carroll, *Spacetime and geometry: an introduction to general relativity (Addison-Wesley,* 2003).

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

- B. Ryden, *Introduction to cosmology* (Cambridge university press, 2016).

- M. P. Hobson, G. Efstathiou and A. N. Lasenby, *General Relativity* (Cambridge Univertity Press, 2006).

***TEACHING METHOD***

Lectures in classroom.

***ASSESSMENT METHOD AND CRITERIA***

Oral examination. The oral exam intends to evaluate the assimilation of the concepts presented during the course, and will focus on the candidate's discussion and presentation of some points of the program. The evaluation of the oral test will take into account the correctness of the answers, their logical and methodological rigor, and the effectiveness of the presentation.

***NOTES AND PREREQUISITES***

Knowledge of special relativity is needed for a good understanding of the course.

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