# Quantum Field Theories

## Prof. Roberto Auzzi

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

The course aims to treat quantum field theories involving spin ½ and spin 1 particles.

At the end of the course, the student will be able to compute scattering amplitudes involving spin ½ and spin 1 at tree level and will understand how to apply the renormalization group to this class of theories. The student will appreciate the relevance of asymptotic freedom, confinement and spontaneous symmetry breaking in QCD.

***COURSE CONTENT***

Feynman rules for Yukawa theory and quantum electrodynamics. Amplitudes and cross sections for positron-electron annihilation and Compton scattering

Scale transformations and trace anomaly: the Callan-Symanzik equation

Asymptotic freedom in non-abelian gauge theories. Wilson loop and confinement. Effective lagrangians for the Pseudo-Goldstone bosons in QCD.

The Standard Model. The Yukawa sector. The Cabibbo-Kobayashi-Maskawa matrix. Neutrino masses and oscillations. Chiral anomaly. Anomaly cancellations in the Standard Model.

False vacuum decay via Coleman-De Luccia instanton. Metastability of the vacuum of the Standard Model

Introduction to the AdS/CFT correspondence

***BIBLIOGRAPHY***

- M. D. Schwartz, *Quantum Field Theory and the Standard Model (Cambridge Univ. Press,* 2014).

- M. SREDNICKI, *Quantum Field Theory* (Cambridge Univ. Press, 2007).

- M. PESKIN AND D.V. SCHROEDER, *An introduction to quantum field theory* (Westview, 1995).

- A. ZEE, *Quantum field theory in a nutshell* (Princeton University Press, 2010).

***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***

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