Bucharest 2025 PhD School:

"Modern Methods in Quantum Gravity and Cosmology"

July 1-6, 2025, Bucharest-Magurele, Faculty of Physics

Lecture series:

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Simulations in Cosmology: From fundamental physics to numerical simulations

Abstract: Recent observational cosmology has opened the possibility of new physics in our description of the Universe, which has led to a number of novel theoretical and numerical questions regarding these emerging physical theories. Moreover, any new candidate cosmological model must be assessed against observational data. In this lecture series, the relationship between fundamental physics and numerical simulations will be covered both at background and perturbative level. This will be done for the standard model of cosmology, LCDM, as well as some potentially realistic extensions of the concordance model. In all cases, the methods used to obtain constraints using the latest observational data will also be covered. This will include using Markov chain Monte Carlo approaches together with methods to assess the viability of different cosmological models. the principle aim of the series will be to learn how to turn fully developed theoretical models into numerical simulations and how to use observational data sets to confront these models with real-world measurements. The three lectures will be divided as follows:

1. General discussion on cosmic tensions
2. An example case of teleparallel cosmology - Theory and foundations
3. An example case of teleparallel cosmology - Observational constraints and current status

The tutorial will consist in a simple example of using MCMC to constrain some cosmological models based on arXiv:2108.03853.

References:

https://arxiv.org/abs/2504. https://arxiv.org/abs/2106. https://cosmoversetensions.eu/ - CosmoVerse training series

Tutorial (emcee):

https://emcee.readthedocs.io/