

# Tonale Winter School on Cosmology



**XIV Tonale Winter School on Cosmology**  
**Theory for Observers, Observations for Theorists**

**Sunday, 6 December 2020 - Friday, 11 December 2020**

**Passo del Tonale (TN) Italy**

## Scientific Programme

*Cosmological simulations***Marco Baldi** (University of Bologna)

In these lectures I will provide a general overview about the techniques and the possible applications of Cosmological Simulations of the Dark Sector of the Universe. In particular, the first two lectures will cover standard numerical methods for the simulation of structure formation in an expanding universe, while the last two lectures will focus more in detail on extended algorithms to investigate Dark Energy, Modified Gravity, and alternative Dark Matter particle candidates.

*Testing fundamental physics with gravitational waves***Juan Garcia-Bellido** (Universidad Autónoma Madrid),

Gravitational waves from black holes and neutron star binaries

Stochastic Backgrounds of Gravitational Waves: from the Early to the Late Universe

Multimessenger astronomy and tests of the theory of gravity

Primordial black holes and the nature of dark matter

*Statistics in Cosmology***Emille Ishida** (Université Clermont Auvergne)

The goal of these lectures is to give students a broad description of key aspects of statistics useful in cosmological analysis. I will begin with a theoretical introduction to statistical thinking through frequentist and Bayesian paradigms. Afterwards, I will describe to the details of Markov Chain Monte Carlo Methods and their role in cosmological analysis. I will also discuss likelihood-free approaches and open discussions into the statistical aspects of machine learning in its first formulations.

*Cosmology with SKA***Laura Wolz** (University of Manchester)

Introduction to radio astronomy: single dish telescopes and interferometers

Overview on the Square Kilometre Array and pathfinders

Cosmological observables in the radio wavelengths: radio continuum and HI spectral line

Intensity mapping of the neutral hydrogen

Dark energy and other cosmological constraints from the SKA