UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Experimental Cosmology

2627-1-F5803Q009

Aims

Knowledge of observational evidences and experimental techniques for cosmology.

Dublin Descriptor 1 – Conoscenza e comprensione

Knowledge of observational evidences and experimental techniques in cosmology.

Dublin Descriptor 2 – Capacità di applicare conoscenza e comprensione

Apply the scientific method and data analysis methodologies to cosmological experiments and observations.

Dublin Descriptor 3 – Autonomia di giudizio

Critically evaluate experimental results and theoretical models in cosmology.

Dublin Descriptor 4 – Abilità comunicative

Communicate clearly using scientific language, both written and oral, in national and international contexts.

Dublin Descriptor 5 – Capacità di apprendimento

Independently consult and integrate advanced scientific publications for continuous updating

Contents

Elements of cosmology: the early Universe and its evolution. The standard model of cosmology and its observational probes. Cosmic Microwave Background: history and current status of measurements and results.

Physical observables, cosmological parameters and experimental techniques.

Detailed program

Part 1: Introduction to Physical Cosmology

- Historical Overview
- Cosmological principle
- Curvature and its implications
- Metric
- The Friedmann-Robertson-Walker metric
- Friedmann's equations
- Density parameters and cosmological constant
- Peculiar solutions to Friedmann's equations
- Benchmark model

Part 2 – Observational probes of the Big Bang model

- Distance measurements: definitions
- Standard candles and standard rulers
- Cosmology with distance measurements
- The distance ladder
- Cosmological standard candles
- Type Ia supernovae
- The measurement of H0
- Discovery and meaning of the Cosmic Microwave Background
- Big Bang Nucleosynthesis
- Reionization
- HI mapping through the 21cm line

Part 3 Cosmic Microwave Backgorund

- Origin of the CMB blackbody
- Recombination, photon decoupling, last scattering
- History of CMB measurements
- Spectral distortions
- CMB anisotropies: basic quantities
- CMB power spectrum: structure and features and their physical motivation
- Temperature anisotropy measurements
- CMB instruments, experimental techniques, calibration, control of systematics
- From time ordered data to maps, to power spectra, to cosmology
- CMB Foregrounds
- CMB temperature anisotropy results
- CMB polarization anisotropies
- Primordial gravitational wabes and inflation
- CMB polarization: current status and near future
- CMB statistics

Part 4 – Large scale structure and Galaxy Clusters

- The matter power spectrum and the 2-point correlation function
- Baryon Acoustic Oscillations (BAO)

- Cosmological results from BAO
- Outlines of cosmology with gravitational Lensing
- Galaxy Clusters: definitions and properties
- Cosmology with Galaxy Clusters, SZ effect

Prerequisites

Teaching form

The course is 6CFU, for a total of 44 hours, divided into 22 2-hour sessions, which include lectures and exercises, all in instructional, traditional (*erogativo*) teaching way.

Textbook and teaching resource

Course slides and notes

B. Ryden, Introduction to Cosmology

S. Serjeant, Observational Cosmology

Articles indicated during lectures

Semester

Second semester

Assessment method

Oral exam (presentation + open questions)

The examination is on appointment with the teacher, will last between 30' and 1h, and it is composed of two parts:

Part 1:
A 15 minute presentation by the candidate, making use of slides and/or the blackboard on one of the course's topics (please send via email a PDF version of the slides before the examination). The candidate is required to investigate and present the topic by using the material and the bibliography shown during the course lactures. This part allows to assess the candidate's ability to present complex topics in a clear way, to further investigate the topics through scientific papers, and her/his analysis and synthesis skills.

Part 2
Questions and discussions, both on the presentation's topics, and on any other course's topic. This part allows to evaulate te candidate's understanding of any of the course topics, linking experimental results and theoretical

models to build the modern view of the Universe birth, evolution and composition.

Office hours

Tue. 9:00-10:00 or by appointment

Sustainable Development Goals

INDUSTRY, INNOVATION AND INFRASTRUCTURE