



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## SYLLABUS DEL CORSO

### Modern Cosmology and Galaxy Formation

2425-1-F5802Q022

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#### Aims

Acquire basic knowledge and develop a "big picture" grasp of major topics in Modern Cosmology and Galaxy Formation in the early Universe. Build a Master-level foundation for understanding current ongoing theoretical research and observational efforts in the field. Develop practical research skills and tools, the ability to formulate meaningful questions and hypotheses, and devise strategies to test them.

#### Contents

The rapidly expanding field of galaxy formation lies at the interfaces of astronomy, particle physics, and cosmology. Covering diverse topics from these disciplines, all of which are needed to understand how cosmic structures form and evolve, this course will explore the evolution of the Universe as a whole and its particle and radiation content; the statistical characteristics of the large-scale structure of the Universe; the linear and nonlinear growth of dark matter halos, the processes affecting the gaseous and dark matter components of galaxies and clusters, and the thermodynamics and chemistry of cosmic baryons. Emphasizing both observational and theoretical aspects, this course will provide a coherent introduction for astrophysics students to the broad range of science underlying the formation and evolution of galaxies. A number of massive data sets from new ground- and space-based instruments and facilities over the next decade are poised to revolutionize our understanding of primeval galaxies, the reionization photon budget and timeline, the physics and the fine-grained properties of gas in the "cosmic web".

#### Detailed program

Smooth Homogeneous Universes, Cosmic Dynamics, Observational Tools in Cosmology, Thermal History and Recombination, Early Universe and Dark Matter, MACHOS and WIMPS, N-Body Simulations, Gaussian Random Fields, Gravitational Instability, Jeans Mass and Baryonic Acoustic Oscillations, Non-Linear Evolution and the

Formation of Dark Matter Halos, Emerging from the Dark Ages, 21-cm Cosmology, Kompaneets Equation and the SZ Effect, The Cosmic History of Star Formation, First Results from the James Webb Space Telescope.

## **Prerequisites**

Mathematics and Physics for students of the bachelor's degree. Basic knowledge of electromagnetism, gravitation, relativity, particle and atomic physics, statistical physics and thermodynamics. It is useful (but not required, as the course is largely self-contained) to take this class after the first-semester courses of the Astrophysics and Space Physics Master.

## **Teaching form**

The lectures (6 CFU, 42 hours) will be held in English. I will frequently propose during the lectures questions and problems (not graded) to be solved individually or in groups. All the material will be made available online, but class attendance and active participation are integral parts of the teaching-learning process.

## **Textbook and teaching resource**

There is no official textbook for this course. However, you will find most of the topics we cover in these books:

Peebles, Peebles Principles of Physical Cosmology. ISBN: 0691019339

Longair, Galaxy Formation. ISBN: 978-3-540-73477-2

Mo, van den Bosch, & White, Galaxy Formation and Evolution. ISBN: 9780511727726

Padmanabhan, Theoretical Astrophysics Volume III. ISBN:0521566304

The instructors notes will be made available on the e-learning page of the course.

## **Semester**

Second Semester.

## **Assessment method**

Final exam is based on oral discussion on the concepts and practices of the courses. The examination will last about 40 min, and it is composed of a 15-20 min presentation by the candidate on a selected subject (previously agreed between the student and the instructor) of cosmology/galaxy formation, making use of slides and/or the blackboard. The second part consists of questions and discussions that will test the student qualitative and quantitative understanding of key concepts, and her/his ability to perform analytical calculations. The oral exam can be carried out in English.

## **Office hours**

By appointment (via email).

## **Sustainable Development Goals**

QUALITY EDUCATION

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