UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

SYLLABUS DEL CORSO

Cosmic Structure Formation

2223-1-F5802Q007

Aims

In this course, the students will learn how to investigate the properties and physical origin of the largest baryonic structures in the universe through the study of their radiation. The course spans a large range in the universe's history and radiation spectrum: from X-ray emitting Intra Cluster Medium in the local universe to Cosmic Web UV emission and absorption, to HI radio emission during Reionization. In the final part of the course, the students will investigate how galaxies formed and developed in the context of the large scale structure of the universe. A strong focus will be also put on learning and improving research practice.

Contents

Content goals/objectives include:

- The students will learn how to investigate and characterise the physical properties of the largest baryonic structures in the universe by studying in detail the mechanisms that produce and modify the electromagnetic radiation detectable with astronomical observing facilities.

- The students will learn that radiation processes are an active agent in shaping the formation and evolution of cosmic structures in the universe from the largest scales associated with intergalactic gas to galaxies.

- The students will learn how to use astronomical observations at different wavelengths to infer physical properties (mass, star formation rate, composition) of galaxies and their constituents (stars, interstellar medium, dark matter).

- The students will learn about the diversity of galaxies in the universe, in terms of, e.g., morphology, kinematics, stellar populations, properties of the interstellar medium. In this context, the students will learn how to identify possible trends and regularities, which may be then used as possible clues to their physical origin.

Practice goals/objectives include:

- The students will learn how to combine the observational data and theoretical models to formulate meaningful questions and hypotheses on cosmic structure and galaxy formation, as well as strategies to test them.

- Through this course, the students will learn/consolidate the fundamental skills in scientific research practice including: i) asking and refining scientific questions, ii) finding relevant variables in physical problems, iii) making testable predictions, iv) making relevant assumptions, v) reducing complex problems in smaller units, vi) effectively sharing and communicating the results.

Detailed program

In order to achieve the learning goals described above, the course is designed through a series of activities which will cover the following topics:

- Inferring the physical properties of the Intra Cluster Medium in Galaxy Clusters (X-ray, high-energy radiation processes)

- Detecting and studying Intergalactic gas in the Cosmic Web in absorption and emission (UV/optical absorption and emission of Hydrogen Ly-alpha radiation, Radiative Transfer)

- The physics of Radiative Cooling and how radiation processes shape cosmic structure formation, galaxy formation and galaxy evolution.

- Cosmic Reionization and radio emission from neutral hydrogen in the early universe and the effect of Reionization on galaxy formation and evolution.

- The physics of the Interstellar Medium, positive and negative feedback processes and how galaxies form their stars.

Prerequisites

The course is geared towards students in the physical sciences with no particular prerequisites on previous classes or study background. The only prerequisites necessary for this class are: i) motivation, ii) curiosity, iii) willingness to actively participate.

Teaching form

The course is designed through inquiry-based-learning activities lead by the students themselves and facilitated by the instructors, in which the students will be able to choose their own investigation path, develop their own material and, finally, share their findings with their peers in a equitable and inclusive environment.

Textbook and teaching resource

Class material will include: i) power point and black-board presentations, ii) material developed in the class during the activities by the students, iii) research papers and reviews, iv) extracts from books (provided during the class when necessary).

Some of the material will be made available online but it is expected that a large fraction of the material/notes will be produced during the classroom activities. Therefore, class attendance and active participation are fundamental factors for both learning and assessment during this course and for the exam.

Semester

First Semester.

Assessment method

Final culminating assessment based on oral discussion on the topics and practices of the courses. The exam is structured as a investigation chosen by the student similarly to the investigations practiced during the course. During the exam, both fundational scientific content and scientific practices taught in the course (described in session "contents") will be assessed. In particular, the following scientific practices will be evaluated: i) asking and refining scientific questions, ii) finding relevant variables in physical problems, iii) making testable predictions, iv) making relevant assumptions, v) reducing complex problems in smaller units, vi) effectively sharing and communicating the results.

Office hours

By appointment (via email).

Sustainable Development Goals

QUALITY EDUCATION | GENDER EQUALITY