



UNIVERSITÀ  
DEGLI STUDI DI MILANO-BICOCCA

## COURSE SYLLABUS

### Cosmic Rays

2324-1-F5802Q013

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#### Aims

Introduce physics of Cosmic Rays and their relevance for Astrophysics, production sources, propagation environments and processes.

At the end of the course the students will know:

- the main observational properties of cosmic rays and how they are detected
- the main sources of cosmic rays and their properties
- how to describe the propagation of cosmic rays in space
- the connections between cosmic rays, cosmology and fundamental physics
- the properties of space environment and the radiation risk

#### Contents

Cosmic rays (CR) are described in relation to observations, their composition and properties. Main topics are: origin and astrophysical sources of CR; acceleration processes; interaction with interstellar medium; propagation in the Milky Way; interaction with solar wind; propagation in the heliosphere; interaction with the Earth magnetic field and atmosphere; CR studies in relation to fundamental physics and cosmology.

#### Detailed program

- **Observational properties of Cosmic Rays:**  
*content.* spectral intensity, energy density and composition. Main scientific results observing CR, current experimental activities from the ground and in space.

*skills*: techniques and strategy for cosmic rays observation.

- **Origin of Cosmic Rays:**

*content*: acceleration processes, galactic and extragalactic astrophysical sources.

*skills*: physical mechanisms of energy transfer to cosmic rays.

- **Interaction of CR with interstellar medium and propagation in the Milky Way:**

*content*: diffusive models and confinement processes, energy loss processes and electromagnetic radiation from CR, spallation processes and secondary component production.

*skills*: solutions for diffusion equation; numerical codes of CR propagation in the ISM.

- **Interaction with solar wind and solar modulation:**

*content*: solar magnetic activity, solar particle emission, the structure of heliosphere.

*skills*: solutions for the transport equation; numerical codes of propagation in heliosphere.

- **Interaction with Earth magnetic field and atmosphere:**

*content*: radiation belts and geomagnetic cut-off, extensive air showers and observations of highest energy CR.

*skills*: space environment and radiation risk; CR tracing in the magnetic field; Extensive Air Showers techniques.

- **Relevance of Cosmic Rays for fundamental physics and cosmology:**

*content*: new physics research, production details in stellar nucleosynthesis, Dark Matter, Cosmologic Anti-matter, CRs of extragalactic origin.

## Prerequisites

knowledge of the previous courses of physics (bachelor degree)

## Teaching form

Front teaching. Lectures with students in presence.

## Textbook and teaching resource

Reference textbooks and resources:

1. Slides and notes of the lectures, provided by the lecturer.
2. High Energy Astrophysics, M.S. Longair, Cambridge University press, third edition, ISBN 978-0-521-75618-1;
3. Space Physics – An introduction, C.T. Russel, J.G. Luhmann, R.J. Strangeway, Cambridge University press, ISBN 978-1-107-09882-4.

## Semester

Second semester

## **Assessment method**

Final evaluation, with a score up to thirty, through an oral interview. Students will be asked to prepare a presentation through which to present and discuss a topic of their choice from the course. The student's maturity, mastery of the subject exposed and clarity and property in the language will be assessed. Furthermore, the critical ability of the student will be assessed, through the connections between the topic presented with other topics included in the class and to general topics among those treated in the degree course.

## **Office hours**

Tentatively every working Monday during the course, from 12:30 pm to 1:30 pm. Otherwise on request. This calendar is depending on the final lectures timetable.

## **Sustainable Development Goals**

QUALITY EDUCATION | INDUSTRY, INNOVATION AND INFRASTRUCTURE | CLIMATE ACTION

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