UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# COURSE SYLLABUS

## Astronomical Instrumentation

**2627-1-F5803Q010**

### Aims

Let the student be familiar with the functioning of the modern ground-based and space-based astronomical instrumentation so that she/he can understand the scientific literature related to instrumentation and be aware of the specific characterisitcs of the instruments getting the data she/is asked to analyze during her/his thesis. Learn how to communicate research results to an audience of professionals.

### Contents

Introduction to the principles of functioning of the telescopes and electromagnetic, gravitational and particle radiation detectors for ground-based and space-based observations.

### Detailed program

Optics review:

- Geometrical optics
- Concepts of Gaussian optics
- Electromagnetic wave polarization: Stokes parameters.

Astronomical Coordinates

- Local Coordinates (alt-azi)
- Equatorial Coordinates
- Galactic Coordinates

Telescopes:

- main optical schemes
- mountings
- angular resolution
- atmospheric absorption
- seeing
- active/adaptive optic

Radio Astronomy:

- single antenna telescopes
- interferometers
- riceivers
- spectrometers
- polarimeters

Millimetric and Sub-millimetric Astronomy:

- telescopes
- etherodyne receivers SIS
- bolometric receivers
- TES
- mKIDS

Infrared Astronomy:

- telescopes
- adaptive/active optics
- infrared arrays

Optical Astronomy:

- telescopes
- CCD cameras
- photometric systems
- spectroscopes

Ultraviolet Astronomy:

- Normal and grazing incidence telescopes
- UV CCD
- Micro-Channel Plates
- Avalanche Photo Diodes

X ray Astronomy:

- grazing incidence telescopes
- coded mask telescopes
- collimators

Gamma ray Astrnomy

- Cerenkov Telescopes
- Showers detectors

Inonizing radiation detectors:

- ionization chambers
- proportional chambers
- Geiger
- scintillators
- photomultipliers
- semiconductor detectors

Gravitational antennas

- Strain Ratio, sensitivity
- Weber Resonators
- Interferometers
- LIGO
- VIRGO
- LISA

Cryogenerators

- Heat transfer: conductivity, convectivity, radiation
- T>180K fridges
- T<180K fridges
- "wet"/"dry"
- $^3$He fridge
- Dilution fridge
- Adiabatic Demagnetization Refrigerator

Space Observatories

- Orbit definition
- Launchers
- Satellite structure
    - Service Module
    - Payload
    - Mass and power budget limits
    - Attitude and pointing systems
- Ground segment

Educational trip to a national observational facility (possible destinations are the INAF radio telescopes, the EGO/VIRGO observatory, the Asiago observatory, an aerospace/high-tech industry that has an instrument or payload in advanced development)

## Prerequisites

Physics 1, Physics 2, Physics 3, Structure of Matters

This course is recommended to students wishing to follow an observational/experimental track during their studies

## Teaching form

Frontal lessons (**traditional form**), eventually in streaming if there are students attending from remote because of visa problems.

## Textbook and teaching resource

Lesson slides.

Textbook:
“Electronic Imaging in Astronomy”, McLean, Springer 2008

suggested books:
"Radio Astronomy", John D. Kraus, Cygnus Quasar Books
"Radiation Detection and Measurements", Glenn Knol, Weyley
"Observational Astrophysics", Pierre Lenà, Springer

## Semester

Second Semester.

## Assessment method

Oral exam in the form of two short seminars on two instruments and/or space missions active in these years agreed with the teacher and questions on topics covered in class but not covered by the two short seminars.

## Office hours

Any day by appointment (email).

## Sustainable Development Goals

QUALITY EDUCATION | INDUSTRY, INNOVATION AND INFRASTRUCTURE | PARTNERSHIPS FOR THE GOALS