UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Astronomical Instrumentation

2526-1-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