UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

# SYLLABUS DEL CORSO

## Radiative Processes

**2223-1-F5802Q011**

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### Aims

Knowledge of the radiative processes fundamental for the description of the astrophysical sources. Give all instruments to infer the physical properties of cosmic sources on the basis of the received radiation. Modeling of their spetral and variability properties.

### Contents

- The electromagnetic spectrum
- Thermal plasma - Black body - Bremsstrahlung
- Elements of special relativity
- Synchrotron emission and self-absorption
- Direct Compton and Inverse Compton
- Atomic structure and radiative transitions
- Relativistic beaming
- Theory of accretion onto black holes and spectral emission
- Active Galactic Nuclei: phenomenology and interpretation - Inference of their fundamental physical parameters
- High energy sources of stellar origin: from pulsars to X-ray binaries

### Detailed program

- Specific Intensity, flux, emissivity, energy density and their relations. Radiative transport. Einstein coefficients and their relations. Thermal and non thermal plasma. Electric field of a moving charge. Larmor formula. Bremsstrahlung and black body emission.

- Special relativity: basic notions. Aberration, beaming and superluminal sources. Relativistic invarinats.
- Synchrotron: relativistic dynamics of charges in magnetic fields. Total power emitted by the single electron. Characteristic frequencies of the emitted spectrum. Self-absorption.
- Thomson scattering: cross section. Direct Compton effect: typical frequencies. Klein Nishina cross section. Inverse Compton scattering. Total power emitted by the single electron and spectral properties. Spactra from non thermal electrons. Thermal Comptonization. Synchrotron self-Compton.
- Radiative transitions and mechanisms of line shift and broadening.
- Bondi model for accretion and the Shakura Sunyaved accretion disc around black holes
- Active Galactic Nuclei: phenomenology. Multiwavelength spectrum of the continuum. Relativistic iron line emission line. Broad and narrow optical emission lines. Molecular torus and unification schemes for Seyfert 1 and 2. X-ray background. Radio loud and radio quiet quasars. Double AGN.
- Pulsaras in the P-Pdot diagram: young and recycled pulsars. X-ray binaries, Gamma-Ray-Burst sources.

## Prerequisites

Classical mechanics, classical electro-magnetism.

## Teaching form

Lectures are frontal.

## Textbook and teaching resource

G.B. Rybicki and A.P. Lightman “Radiative Processes in Astrophysics”
G. Ghisellini: "Radiative processes in high energy astrophysics"
M.S. Longair “High Energy Astrophysics”
J. Krolik “Active Galactic Nuclei. From the Black Hole to the Galactic Environment”
Shapiro and Teukolsky "Black Holes, White Dwarfs and Neutron Stars"
Selected reviews and selected papers provided during the lectures

## Semester

Secondo Semester

## Assessment method

The oral exam will start with the presentation of a topic selected by the student. The exam proceeds with a discussion on the most fundamental processes linking radiation and matter. The first question by the Lecturer will be on the emission processes and the interaction matter-radiation not covered by the student. The second question will be on the astrophysical sources.

## Office hours

Upon email appointment

## Sustainable Development Goals