UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Radiative Processes

2425-1-F5802Q011

Aims

Radiative processes are crucial in astrophysics because they govern how energy is transferred through space and how information about cosmic objects is transmitted to us. This course is an introduction to the radiative processes fundamental for the description of high-energy astrophysical sources. It provides tools to infer the physical properties of cosmic sources based on the received radiation and enables modeling of their spectral and variability properties.

Contents

- The electromagnetic spectrum
- Thermal plasma - Black body - Bremsstrahlung
- Elements of special relativity
- Relativistic beaming
- Synchrotron emission and self-absorption
- Direct Compton and Inverse Compton
- Theory of accretion onto black holes and spectral emission
- Active Galactic Nuclei
- Gamma Ray Bursts
- Pulsars
- 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.
- 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

Frontal lectures, mostly at the blackboard, occasionally with the support of slides including exercises and supporting activities (6 CFU).

Lectures are in English.

Lectures from the previous years are made available to meet the needs of students who might be impeded in personally attending classes.

Textbook and teaching resource

Reference book
G.B. Rybicki and A.P. Lightman “Radiative Processes in Astrophysics” , Chapters 1,3,4,5,6,7

Other books
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

First Semester

Assessment method

The oral exam will start with the presentation of a topic selected by the student on a radiative procces. Thereafter, the teacher will verify knowledge on the main themes treated in the course. Later, the student will discuss a selected class of sources on his/her choice.

Office hours

Upon email appointment

Sustainable Development Goals

QUALITY EDUCATION