UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Radiative Processes

2122-1-F5802Q011

Aims

Have deep knowledge on the radiative processes fundamental for the description of the astrophysical sources. Give all instruments to calculate some fundamental physical properties of cosmic sources on the basis of the received radiation.

Contents

- The electromagnetic spectrum
- The multi-wavelength Universe
- Thermal plasma - Black body - Bremsstrahlung

- Synchrotron emission and self-absorption

- Direct Compton and Inverse Compton
- Atomic structure and radiative transitions
- Relativistic beaming
- Theory of accretion onto black holes
- Active Galactic Nuclei: phenomenology and interpretation - Inference of their fundamental physical parameters

Detailed program

- Luminosity, flux emissivity, energy density and their relations. Radiative transport. Einstein coefficients and their relations. Thermal and non thermal plasma. Coulomb collisions: cross section. Electric field of a moving charge. Larmor formula. Bremsstrahlung and black body.

- Special relativity: basic notions. Bar in motion along its length. Moving square. Aberration. Superluminal cosmic sources. Beaming Statistics of superluminal sources.

- Synchrotron: acceleration, Larmor radius and frequency. Total power emitted by the single electron. Characteristic frequencies. Emitted spectrum. Self-absorption.

- Thomson scattering: cross section. Direct Compton effect: typical frequencies. Klein Nishina cross section: generalities. Eddington luminosity. Typical frequencies emitted by the Inverse Compton process. Total power emitted by the single electron. Thermal Comptonization. Comptonization parameter. Emitted spectra. Synchrotron self-Compton.

- Atomic structure: spin-orbit coupling, Zeeman effect, hyperfine structure.

- Radiative transitions and mechanisms of line broadening.

- Active Galactic Nuclei. Historical introduction. main components. Black hole masses: correlations with the host buldge luminosity and M-sigma relation. Accretion disks. Spectrum. X-ray spectrum as thermal Comptonization.Compton reflection. Relativistic Iron 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

Prerequisites

Classical mechanics, classical electro-magnetism

Teaching form

Lectures are frontal.

Textbook and teaching resource

G. Ghisellini: "Radiative processes in high energy astrophysics"
G.B. Rybicki and A.P. Lightman “Radiative Processes in 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"

Semester

First 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. Some specific topic will be considered, if needed to understand the level of knowledge of the student.

Office hours

Upon email appointment