Universitat Autònoma de Barcelona

High Energy Astrophysics 2016/2017

Code: 42856
ECTS Credits: 6

Degree	Type	Year	Semester
4313861 High Energy Physics, Astrophysics and Cosmology	OT	0	2

Contact

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Use of languages

Principal working language: english (eng)

Teachers

Emma Oña Wilhelmi

Abelardo Moralejo Olaizola

Nanda Rea

Prerequisites

It is mandatory to have followed the course of Introduction to the Physics of the Cosmos. It is also recommended - but not mandatory - to have followed the Observational Techniques course.

Objectives and Contextualisation

Students should become familiar with the basics of High Energy Astrophysics, not only with respect to the sources and astrophysical processes that produce X rays, gamma rays and cosmic rays in our universe, but also with the instruments that detect these photons / particles. The course is divided into three blocks. The first part is a theoretical description of the main processes of interaction of matter and radiation in the X- and gamma-ray energy domain. The second one describes the detectors that are currently operating, those under construction and those being designed. The third and final block presents the phenomenology of several cosmic sources of X rays, gamma rays, cosmic rays that have been observed so far.

Skills

- Formulate and tackle problems, both open and more defined, identifying the most relevant principles and using approaches where necessary to reach a solution, which should be presented with an explanation of the suppositions and approaches.
- Understand the bases of advanced topics selected at the frontier of high energy physics, astrophysics and cosmology and apply them consistently.

Learning outcomes

1. Analyze the different sources of cosmic radiation.
2. Understand the physical processes responsible for the emission, propagation and absorption of cosmic radiation (charged particles, photons and neutrinos).

Content

Outline of the Course

1. Theory
    1. Physical processes. Introduction about cosmic rays, X and gamma rays
2. Detectors
    1. X- and gamma-ray detectors. Main instrumentation in space and ground based, e.g. INTEGRAL, Fermi, Cherenkov telescopes
    2. Cosmic ray detectors
3. The high-energy sky
    1. Accretion powered sources: white dwarfs, neutron stars and black holes in binaries.
    2. Nova and supernova explosions
    3. Supernova remnants, pulsars and pulsar wind nebulae
    4. Gamma-ray emission related to nucleosynthesis. Diffuse and line emission
    5. Gamma-ray emission related to matter anti - matter annihilation
    6. Gamma-Ray Bursts
    7. Other sources of high-energy radiation

Methodology

Theory lectures.

Classwork and homework.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Lectures	44	1.76	1, 2
Type: Supervised			
Written report on a topic, based on a paper and associated references	30	1.2	1, 2
Type: Autonomous			
Homework: study, check of the lecture notes and slides	66	2.64	1, 2

Evaluation

One exam.

Individual work on a research topic, based on a paper provided by the teachers and on the associated references found by the student. A written report and its oral presentation, followed by a discussion with the panel (teachers of the master), should be done.

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Final exam	50%	3	0.12	1, 2
Oral presentation of a research topic	25%	1	0.04	1, 2

Written report of a research topic	25%	6	0.24	1, 2

Bibliography

- Radiation Detection and Measurement, Glenn F. Knoll, Wiley, NJ, USA (2000)
- High Energy Astrophysics, Malcom S. Longair, Vol.1, Cambridge University Press, Cambridge, UK (1992)
- Exploring the X-ray Universe, Philip A. Charles, Frederick D. Seward, Cambridge University Press, Cambridge, UK (1995)
- Radiative Processes in Astrophysics, Rybicki, G. B. and Lightman, A. P., Wiley-VCH Verlag GmbH, Weinheim, Germany (1985)
- Very high energy cosmic gamma radiation : a crucial window on the extreme Universe, F. A. Aharonian, River Edge, NJ: World Scientific Publishing (2004)