Observational Techniques 2016/2017

Code: 42866
ECTS Credits: 6

Degree	Type	Year	Semester
4313861 High Energy Physics, Astrophysics and Cosmology	OT	0	1

Contact

Name: Ignasi Ribas Canudas

Email: Desconegut

Teachers

Josep Colome Ferrer

Josep Miquel Girart Medina

Margarida Hernanz Carbo

Francisco Javier Castander Serentill

Carlos Fernández Sopuerta

Manuel Perger

Gemma Busquet

Use of languages

Principal working language: english (eng)

Prerequisites

No specific prerequisites are set for this course, but it is advisable to possess some basic knowledge of Astronomy and Physics.

Objectives and Contextualisation

The objective of this course is to familiarize the student with the various techniques for observations as used in Astronomy. The student will be required to comprehend basic concepts, nomenclature and unit systems that are commonly employed in astronomical work. Detection techniques and instrumentation will be described as a function of wavelength, including the entire particle and electromagnetic spectrum: neutrino astronomy, gravitational waves, high-energy (gamma-rays and X-rays), UV-optical, near infrared and radio astronomy. For all these regimes, which use different methodologies, data reduction and analysis techniques will be covered. The final goal is that the student acquires sufficient basic knowledge to be able to plan, execute and analyze observations in all branches of Astronomy thus enabling him/her to perform scientific research.

Skills

- Apply the main principles to specific areas such as particle physics, astrophysics of stars, planets and galaxies, cosmology and physics beyond the Standard Model.
- 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.
- Use acquired knowledge as a basis for originality in the application of ideas, often in a research context.

- Use critical reasoning, analytical capacity and the correct technical language and formulate logical arguments.

Learning outcomes

1. Apply the optical principle of the conceptual design of astronomical cameras and telescopes.
2. Make a comparative analysis of the different observation techniques (optical astronomy, radioastronomy, etc.).
3. Plan an optical observation of a series of astronomical objects.
4. Understand the basics of astronomical observations.
5. Understand the basics of optical and infrared astronomy.
6. Understand the basics of radioastronomy.

Content

Basic concepts of astronomy (atmospheric windows, position astronomy, magnitude systems)

Solar observation

UV, optical and infrared astronomy:

- Telescopes: optical and mechanical designs, adaptive optics, observation planning
- Detectors: CCDs, near IR detectors
- Reduction of astronomical images
- Photometry and photometric systems
- Spectroscopy

High-energy astrophysics:

- Detection principles
- Instrumentation
- Data analysis

Radioastronomy:

- Detection principles
- Radiointerferometry
- Data analysis

Gravitational wave astrophysics:

- Basic principles
- Detection
- Instrumentation on the ground and space

Neutrino astrophysics:

- Basic principles
- Detectors

Methodology

Theory lectures and exercises.

Classwork and homework.

Preparation of an essay for oral presentation and preparation of lab reports.

Activities

Title	Hours	ECTS	Learning outcomes
Type: Directed			
Practical labs	6	0.24	3
Theory lectures	38	1.52	1, 2, 4, 5, 6
Type: Supervised			
Practical labs	5	0.2	3
Essay	5	0.2	3, 5, 6
Type: Autonomous			
Discussion, team work	40	1.6	1, 2, 3, 4, 5, 6
Homework	30	1.2	1, 2, 4, 5, 6

Evaluation

The evaluation is composed of an oral presentation plus questions on a topical essay with 60% weight (individual), and the reports from two practical labs on data reduction and analysis with 20% weight each (in small groups).

Evaluation activities

Title	Weighting	Hours	ECTS	Learning outcomes
Preparation, oral presentation and discussion of a topical essay	60%	16	0.64	1, 2, 3, 4, 5, 6
Written report on practical lab on optical photometry	20%	5	0.2	3
Written report on practical lab on X-ray astrophysics	20%	5	0.2	3

Bibliography

- Astrophysical Techniques (CRC Press), C.R. Kitchin, 2013 (6th ed)
- The Design and Construction of Large Optical Telescopes (Springer), Pierre Y. Bely (editor), 2002
- The Sun. An introduction (Springer), Michael Stix, 2002
- Observational Astrophysics (Springer), Pierre Léna et al., 2012 (3rd ed)
- Handbook of CCD Astronomy (Cambridge), Steve B. Howell, 2006
- Handbook of Infrared Astronomy (Cambridge), I.S. Glass, 1999
- Observational Astronomy: Techniques and Instrumentation (Cambridge), Edmund C. Sutton, 2011
- Radiation Detection and Measurement (Wiley), Glenn F. Knoll, 2010 (4th ed)
- High Energy Astrophysics (Cambridge), Malcom S. Longair, 2011 (3rd ed)
- Exploring the X-ray Universe (Cambridge), Philip A. Charles, Frederick D. Seward, 2010 (2nd ed)
- The basics of gravitational wave theory, Eanna E. Flanagan & Scott A. Hughes, New J. Phys., 7, 204, 2005 (arXiv:gr-qc/0501041)
- Lectures on Neutrino Astronomy: Theory and Experiment (Lectures presented at the TASI School), Francis Halzen, 1998 (arXiv:astro-ph/9810368v1)
- Tools of Radio Astronomy (A&A Library, Springer), Kirsten Rohlfs, Thomas L. Wilson, 2009 (5th ed)

- Interferometry and Synthesis in Radio Astronomy (Wiley), A.R. Thompson, J.M. Moran, G.W. Swenson Jr., 2001 (2nd ed)
- An introduction to Radio Astronomy (Cambridge). Bernard F. Burke, Francis Graham-Smith, 2009 (3rd ed)