COURSE DATA

DATA SUBJECT

Code: 34269
Name: Observational astrophysics
Cycle: Undergraduate Studies
ECTS Credits: 4.5
Academic year: 2026-27

STUDY (S)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Facultat de Física	4	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
1105 - Degree in Physics	Complements of Physics	ELECTIVES

COORDINATION

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SUMMARY

The course «Observational Astrophysics» is optional and forms part of «Complements in Physics». Its contents are taught during the first semester of the fourth year of the Degree in Physics through 4.5 ECTS. It is related to the subject «Physics of the Earth and the Cosmos», the contents of which are taught through the courses «Physics of the Atmosphere», in the second year of the degree, and «Astrophysics» in the third year.

This laboratory-structured course is based on the realisation of practices in which students reduce and analyse astronomical data making use of standard astronomical software. The data to work with has been obtained by professional astronomers or amateurs, as well as by the students themselves in sessions of in-site astronomical observation or remote observing in the Observatorio de Aras de los Olmos.

After presenting the basic concepts of positional astronomy, study of the light, telescopes and astronomical detectors, we describe and analyse different observational astrophysical techniques: astrometry, photometry and spectroscopy. The main guide of the subject in applying the different techniques is as follows: first, the planning of the astronomical observations or the acquisition of data from archives; second, the analysis of the type of information provided by the telescope and the detector; then, the study of the data processing and reduction techniques to render them directly interpretable and, finally,

the interpretation and the study of the physical information that can be extracted from the already-processed data. The final phase will be to write a report of the activity or project and, eventually, to present the results publicly to the rest of the class.

class.

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

OTHER REQUIREMENTS

Students of the subject have previously studied the Astrophysics compulsory subject in the second half of the third year. Thus, they already have the basic knowledge about the astronomical coordinates, stellar atmospheres, stellar structure and evolution, galactic structure, galaxies and cosmology. They should also have some knowledge of astronomical photometry and spectroscopy. This knowledge is recommended for the proper understanding of the practical work to develop.

COMPETENCES / LEARNING OUTCOMES

1105 - Degree in Physics

Ability to collect and interpret relevant data in order to make judgements.

Basic & applied Research: acquire an understanding of the nature and ways of physics research and of how physics research is applicable to many fields other than physics, e.g. engineering; be able to design experimental and/or theoretical procedures for: (i) solving current problems in academic or industrial research; (ii) improving the existing results.

Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.

Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.

Knowledge and understanding of the fundamentals of physics in theoretical and experimental aspects, and the mathematical background needed for its formulation.

Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.

Literature Search: be able to search for and use physical and other technical literature, as well as any other sources of information relevant to research work and technical project development.

Modelling & Problem solving skills: be able to identify the essentials of a process / situation and to set up a working model of the same; be able to perform the required approximations so as to reduce a problem to an approachable one. Critical thinking to construct physical models.

Physics general culture: Be familiar with the most important areas of physics and with those approaches which span many areas in physics, or connections of physics with other sciences.

Problem solving: be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems .

Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.

Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.

Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.

Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.

To know how to apply the knowledge acquired to professional activity, to know how to solve problems and develop and defend arguments, relying on this knowledge.

DESCRIPTION OF CONTENTS

1. The celestial sphere and the coordinate systems

- Celestial coordinates: transformations
- Precession and nutation
- Measure of the time. Julian date.
- Astronomical charts and Catalogues

2. Light, matter, and radiation

- Magnitudes
- Filters and photometric systems

- Colour index
- Spectral Lines
- Doppler Effect

3. Telescopes

- Optical elements
- Magnitude limit
- Angular sesolution
- Types of telescopes: reflectors and refractors
- Telescope Mountings.
- Aberration and field of view

4. Astronomical detectors

- CCD
- Digital images. Pixels, colour and grey scale. Brightnest and contrast.
- Reduction of images CCD
- Bad pixels and cosmic rays
- Bias and dark current substractionb
- Flat-fielding
- Software for image analysis (ImageJ)

5. Astrometry

- Measurement of the positions of astronomical objects on CCD images
- Corrections and errors
- On-line software for astrometry: astrometry.net

6. Photometry

- Aperture selection
- Magnitude calibration
- Extinction and zero-point offset

- Aperture and PSF photometry

7. Spectroscopy

- Flat field correction
- Wavelength calibration
- Flux calibration
- Software for spectral analysis

8. Exercises and laboratories

1. Exercises positional astronomy and measurement of time.
2. Laboratory with planetary software: Stellarium.
3. Planning astronomical observations (Staralt).
4. Adquisition of astronomical images (in the Observatorio de Aras de los Olmos).
5. Image reduction (correction of dark current, bias and flat field).
6. Creation of colour images from frames with three filters.
7. Laboratory of astrometry.
8. Laboratory of photometry.
9. Laboratory of spectroscopy.

9. Final Project of the subject

1. Projects of Photometry: Derivation of light curves:
1.1 Differential photometry: light curves.
1.2 Standard photometry: HR diagram of a cluster.
2. Projects of spectroscopy:
2.1 Displaying spectra of stars of different types.
2.2 Measurement of quasar redshifts.
2.3 Measure and modelling of emission lines.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	0,00
Laboratory	45,00
Total hours	**45,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	6,50
Individual or group project	40,00
Independent study and work	13,00
Preparation of lessons	3,00
Preparation for assessment activities	5,00
Resolution of case studies	0,00
Total hours	**67,50**

TEACHING METHODOLOGY

The course is structured in 13 sessions of 3.5 hours each. Each session compresses typically two parts:

1. Explanation of the most important contents of each subject of the syllabus of the course, description of telescopes, detectors and analysis techniques or the software used in observational astrophysics for the analysis and reduction of astronomical data that will use in the laboratory sessions, collective discussion of conceptual difficulties and resolution of doubts: 1.5 hours.
2. Training activity with computers at the classroom of astronomy, making use of different standard software of astronomy (stellarium, staralt, IRAF, ImageJ, SalsaJ, astrometry.net, etc.) and astronomical databases (SIMBAD) or tools of the virtual observatory: 2.5 hours

One of the sessions will take place in the Observatorio de Aras de los Olmos.

In general, the laboratory work will be performed in groups of two or three people, supervised by the professor of the course. Prior to each session of laboratory, the professor will deliver, through the virtual classroom, a guide of the training activity, with indications for downloading the necessary data to carry out it, as well as the necessary information (a small script) to perform the activity (by means of a small script).

Each student or work team has to present a brief report of each one of the training activities (described in the section 8 of the description of the contents) within the dates that will be fixed for this propose.
A final project of the subject (one from the list in section 9 of the description of contents) will proposed to student each team at the beginning of the last month of the course. The last sessions of laboratory will be devoted to work on this project. In this case, the report that has to be ellaboated should be more complete and should include an introduction to the goals of the project, a description of the employed astrophysical techniques, a detailed explanation of the process of data reduction and analysis, as well as a well elaborated presentation of the obtained results.

EVALUATION

The evaluation will consist in the following parts:

- Continuous assessment (70%):
    - Assessment of the resolution of the exercises and the evaluation of the reports of the training activities that are outlined in section eight of the description of contents. These activities will be carried out individually or by couples (as it will be indicated).
    - Assessment of the report and of the oral presentation in class of on the assigned project of observational astrophysics that appear in the section nine of the description of contents. The work will carry out in groups of two or three people, with the supervision of the professor.
    - Assessment of the attendance to the classes, the participation in the proposed activities, the capacity to work in teams and the skills in using of the proposed techniques.
- Examination (30%):
    - Assessment of a written test based on the knowledge and skills acquired during the course.

These evaluation criteria are common to the first and second calls.

REFERENCES

- To Measure the Sky, Frederick R. Chromey, Cambridge University Press, 2010

- Observing the Universe, Edited by Andrew J. Norton, Cambridge University Press, 2004

- Astrophysical Techniques, C.R. Kitchin, Institute of Physics Publishing, U.K., 1995

- Observational Astronomy, 2nd Edition, D. Scott Birney, Guillermo Gonzalez, David Oesper, Cambridge University Press, 2006

- Optical Astronomical Spectroscopy C.R. Kitchin, Adam Hilger, U.K., 1991

- Astronomical Photometry, C. Sterken y J. Manfroid, Kluwer Academic Publishers, The Netherlands, 1992