Universitat Autònoma de Barcelona

2023/2024

Introduction to Nuclear and Particle Physics

Code: 103949
ECTS Credits: 5

Degree	Type	Year	Semester
2500097 Physics	OT	3	2

Contact

Name: Maria del Pilar Casado Lechuga

Email: pilar.casado@uab.cat

Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

Teachers

Carlos Domingo Miralles

Maria del Pilar Casado Lechuga

José Flix Molina

Maria Jose Garcia Fuste

Prerequisites

There are none.

Objectives and Contextualisation

Study of the physics of atomic nuclei.

Study of the basic components of matter, elementary particles.

Competences

- Act with ethical responsibility and respect for fundamental rights and duties, diversity and democratic values.
- Apply fundamental principles to the qualitative and quantitative study of various specific areas in physics
- Be familiar with the bases of certain advanced topics, including current developments on the parameters of physics that one could subsequently develop more fully
- Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, and before both specialist and general publics
- Develop the capacity for analysis and synthesis that allows the acquisition of knowledge and skills in different fields of physics, and apply to these fields the skills inherent within the degree of physics, contributing innovative and competitive proposals.
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Take account of social, economic and environmental impacts when operating within one's own area of knowledge.
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Use mathematics to describe the physical world, selecting appropriate tools, building appropriate models, interpreting and comparing results critically with experimentation and observation
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project

Learning Outcomes

1. Calculate the kinematics of nuclear reactions.
2. Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, in front of both specialist and general publics.
3. Describe medical, industrial and energy-based applications of nuclear and particle physics technology.
4. Describe the basic nuclear models (Establishers, liquid drop, rotational-vibrational).
5. Describe the classification of subatomic particles based on fundamental constituents.
6. Describe the constituents of matter.
7. Describe the main features of the atomic nucleus, its stability, shape and size.
8. Describe the operation of radiation detectors.
9. Describe the production and properties of radioisotopes.
10. Establish the foundation for quantum field theory and the description of fundamental interactions.
11. Establish the foundation for the study of astrophysics (nuclear collisions, fusion, fission, the neutrino physics of the Sun and supernovae).
12. Establish the foundation for the study of cosmology (big bang, expansion of the universe, and inflation).
13. Establish the foundation for the study of radiation physics and its applications.
14. Explain the explicit or implicit code of practice of one's own area of knowledge.
15. Identify situations in which a change or improvement is needed.
16. Identify the social, economic and environmental implications of academic and professional activities within one's own area of knowledge.
17. Qualitatively describe fundamental interactions.
18. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
19. Use groups in the description of symmetries.
20. Use relativistic kinematics in the description of particle interactions.
21. Use the mathematical formulation of quantum mechanics.
22. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.

Content

Nuclear properties; semiempirical formula of the mass; nuclear stability, alpha, beta and

gamma disintegrations and selection rules; dispersion, effective section and form factor;

distribution of cargo and nuclear matter; strong nuclear interaction between nucleons;

nuclear structure; collisions and nuclear reactions

Elementary particles: quarks and leptons; fundamental interactions; relat

symmetries and conservation laws; specific properties of the fundamental interactions.

Methodology

Part of the tutorials was used to perform continuous evaluation.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Theoretical and problem classes	41	1.64	1, 6, 4, 5, 7, 17, 11, 13, 10, 18, 19, 20, 21
Type: Autonomous			
Own work of the students	69	2.76	1, 8, 6, 4, 5, 9, 3, 7, 17, 12, 13, 18, 20
Tutorials	6	0.24	1, 5, 3, 17

Assessment

The two parts of the subject (nuclear physics and particle physics) are evaluated separately.

The nuclear physics mark is obtained as:

Nuclear mark = 0.6 x Nuclear partial grade + 0.3 x Nuclear test grade + 0.1 x Nuclear deliveries grade

Students who have assessed the partial and do not pass the nuclear physics grade will have the opportunity to take the nuclear physics part of the replay exam, the grade of which will replace the partial exam grade. The grade for the tests and deliveries will remain unchanged, as they are considered continuous evaluation.

The particle physics mark is obtained as:

Particle mark = 0.75 x Partial grade + 0.25 x particle deliveries grade

Students who have assessed the partial and do not pass the particle partial mark will have the opportunity to take the particle physics part of the replay exam, the mark of which will replace the particle physics partial grade.

The final mark of the subject is 0.5 x Nuclear mark + 0.5 x Particle mark, as long as the mark of each partial exam (or its replay) exceeds 3.5 points. Otherwise, the subject is not passed.

Students who will opt for Unique Assessment (UA) will be examined on the day of the 2nd term exam for all the contents of the course.

The duration and place for the UA exam will be agreed during the course. The second test for UA students will take place on the day of the make-up exam with the whole class.

There will be a part for Nuclear and another for Particles. In order to pass the course, the grade on each part must be above 3.5 and the average above 5.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Continuous evaluation tests / monitoring of nuclear physics	15%	1	0.04	1, 8, 6, 4, 9, 3, 7, 11, 12, 13, 15
Delivery of reports and / or works of Nuclear Physics	5%	0	0	1, 8, 6, 4, 3, 7, 11, 13, 16, 18, 22
Delivery of reports and / or works of particle physics	12,5%	0	0	8, 9, 3, 11, 12, 13, 10, 16, 18, 22
Retake exams (theoretical / practical / synthesis) of nuclear physics and particle physics	67,5%	3	0.12	1, 2, 8, 6, 4, 5, 9, 3, 7, 17, 11, 12, 13, 10, 14, 18, 19, 20, 21
Theoretical / practical partial exam / synthesis of Nuclear Physics	30%	2.5	0.1	1, 2, 8, 6, 5, 9, 3, 7, 11, 13, 14, 18
Theoretical / practical partial exam / synthesis of particle physics	37.5%	2.5	0.1	1, 2, 6, 4, 5, 7, 17, 14, 18, 19, 20, 21

Bibliography

Introduction to Elementary Particles, D. Griffiths; John Wiley and Sons, Inc, 1987.

Nuclear and Particle Physics, W.S.C. Williams; Oxford Science Publishing, 1996.

Software

No specific software is required