Universitat Autònoma de Barcelona

**2019/2020**

# Introduction to Nuclear and Particle Physics

Code: 103949
ECTS Credits: 5

| Degree | Type | Year | Semester |
|---|---|---|---|
| 2500097 Physics | OT | 3 | 2 |

## Contact

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## Use of Languages

Principal working language: spanish (spa)
Some groups entirely in English: No
Some groups entirely in Catalan: No
Some groups entirely in Spanish: Yes

## Teachers

Carlos Domingo Miralles

## Prerequisites

There are none.

## Objectives and Contextualisation

Study of the basic components of matter, elementary particles.
Study of the physics of atomic nuclei.

## Competences

- 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
- Develop critical thinking and reasoning and know how to communicate effectively both in the first language(s) and others
- Develop independent learning strategies
- 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.
- Generate innovative and competitive proposals for research and professional activities.
- Respect the diversity and plurality of ideas, people and situations
- 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

## Learning Outcomes

1. Calculate the kinematics of nuclear reactions.
2. Describe medical, industrial and energy-based applications of nuclear and particle physics technology.
3. Describe the basic nuclear models (Establishers, liquid drop, rotational-vibrational).
4. Describe the classification of subatomic particles based on fundamental constituents.
5. Describe the constituents of matter.
6. Describe the main features of the atomic nucleus, its stability, shape and size.
7. Describe the operation of radiation detectors.
8. Describe the production and properties of radioisotopes.
9. Develop critical thinking and reasoning and communicate ideas effectively, both in the mother tongue and in other languages.
10. Develop independent learning strategies.
11. Establish the foundation for quantum field theory and the description of fundamental interactions.
12. Establish the foundation for the study of astrophysics (nuclear collisions, fusion, fission, the neutrino physics of the Sun and supernovae).
13. Establish the foundation for the study of cosmology (big bang, expansion of the universe, and inflation).
14. Establish the foundation for the study of radiation physics and its applications.
15. Generate innovative and competitive proposals for research and professional activities.
16. Qualitatively describe fundamental interactions.
17. Respect diversity in ideas, people and situations.
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.

## 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.

## Activities

| Title | Hours | ECTS | Learning Outcomes |
|---|---|---|---|

| | | | |
|---|---|---|---|
| Type: Directed | | | |
| Theoretical and problem classes | 41 | 1.64 | 1, 5, 3, 4, 6, 16, 9, 12, 14, 11, 18, 19, 20, 21 |
| Type: Autonomous | | | |
| Own work of the students | 69 | 2.76 | 1, 7, 5, 3, 4, 8, 2, 6, 16, 10, 9, 13, 14, 15, 18, 17, 20 |
| Tutorials | 6 | 0.24 | 1, 4, 2, 16, 10, 15 |

## Assessment

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

The final grade of the subject is the average of the marks of both parts, as long as the marks of each of the parts is superior to 3.5 points out of 10.

The note of nuclear physics is obtained as:

Nuclear note = 0.6 x Nuclear partial note + 0.3 x nuclear tests note + 0.1 x nuclear delivery note

The particle physics note is obtained as:

Note particles = 0.75 x Partial note particles + 0.25 x note particle deliveries

The grade of the subject is 0.5 x Nuclear grade + 0.5 x Note particles, provided that the notes of each part exceed 3.5 points. Otherwise, the subject is not passed.

Students who have evaluated the partial and do not pass the course, have the opportunity to submit to the retake exam of the (s) partial (s) that have not passed. Nuclear tests and deliveries of both nuclear physics and particle physics, given their nature of continuous evaluation and monitoring, do not allow re-evaluation.

## Assessment Activities

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

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|---|---|---|---|---|
| Theoretical / practical partial exam / synthesis of particle physics | 37.5% | 2.5 | 0.1 | 1, 5, 3, 4, 6, 16, 10, 9, 15, 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.