GHENT UNIVERSITY

Course Specifications

Valid as from the academic year 2025-2026

Nuclei: Structure, Synthesis and Interactions (C004507)

Course size *(nominal values; actual values may depend on programme)*

Credits 6.0 **Study time 180 h**

Course offerings in academic year 2026-2027

A (semester 2)	English	Gent

Lecturers in academic year 2026-2027

Jachowicz, Natalie	WE05	lecturer-in-charge

Offered in the following programmes in 2026-2027	**crdts**	**offering**
Master of Science in Physics and Astronomy	6	A
Exchange Programme in Physics and Astronomy (Master's Level)	6	A

Teaching languages

English

Keywords

Nuclear structure, nuclear reactions, nucleosynthesis

Position of the course

This course builds on the courses 'Nuclear Physics' in the Bachelor of Physics and Astronomy and 'Subatomic Physics' in the Master Program in Physics and Astronomy. Several concepts that were introduced in these courses are studied in more depth. The focus is on nucleosynthesis and on the electroweak interaction as a tool to investigate the structure of nucleons and nuclei.

Contents

- Nuclear structure ; nuclear abundances
- Deformation and collective models
- Direct versus resonance reaction mechanisms at low energies
- Electroweak interactions with nuclei
- Beta decay and nuclear structure
- Thermonuclear reaction rates ; Gamow window ; shielding
- Big Bang nucleosynthesis
- Stellar nucleosynthesis (including relevant aspects of stellar structure and evolution) ; nucleosynthesis in the sun, solar neutrinos
- The role of atomic nuclei as laboratories for studying fundamental physics processes, relevant experimental efforts

Initial competences

The students master the basic principles of nuclear physics. They have a good working knowledge of quantum mechanics and special relativity.

Final competences

1 The students have a detailed working knowledge of several concepts in nuclear physics.
2 The students can independently or as a team attack problems in this field.
3 The students are able to situate the position of nuclear physics in the description of the microscopic structure of matter.
4 The students are able to explain various key phenomena in nuclear physics and nucleosynthesis in detail.
5 The students are able to describe the main mechanisms for nucleosynthesis in the universe.
6 The students are able show clear understanding of the role of the interplay

between nuclear structure and reactionson one hand and stellar structure and evolution on the other, in stellar nucleosynthesis.
7 The students are familiar with the theoretical framework for the description of electroweak interactions with nucleons and nuclei.
8 The students are familiar with the description of leptonic scattering off nucleons and nuclei, of interactions.
9 The students are able to describe why (leptonic) probes provide a powerful tool to study subatomic systems in scattering interactions.
10 The students are able to apply the concepts mentioned above in problems at an advanced level.

Conditions for credit contract

Access to this course unit via a credit contract is determined after successful competences assessment

Conditions for exam contract

This course unit cannot be taken via an exam contract

Teaching methods

Seminar, Lecture

Study material

Type: Slides

Name: Nuclei : structure, synthesis and interactions
Indicative price: Free or paid by faculty
Optional: no
Oldest Usable Edition : nvt
Available on Ufora : Yes

Type: Handouts

Name: Nuclei : structure, synthesis and interactions
Indicative price: Free or paid by faculty
Optional: no
Language : English
Oldest Usable Edition : nvt
Available on Ufora : Yes

References

'Foundations of nuclear and particle physics', T.W. Donnelly et al, Cambridge ; 'Subatomic Physics', Frauenfelder and Henley ; 'Nuclear Physics', Wong ; 'A modern Primer in Particle and Nuclear Physics', F. Terranova, Oxford, 'An Introduction to Nuclear Astrophysics', R. Boyd, University of Chicago Press ; 'Principles of Stellar Evolution and Nucleosynthesis', D. Clayton, University of Chicago Press ; 'Nuclear Physics of Stars', C. Iliadis, Wiley

Course content-related study coaching

The lecturer can be contacted after the lectures, or by appointment.

Assessment moments

end-of-term assessment

Examination methods in case of periodic assessment during the first examination period

Oral assessment, Written assessment with open-ended questions

Examination methods in case of periodic assessment during the second examination period

Oral assessment, Written assessment with open-ended questions

Examination methods in case of permanent assessment

Presentation

Possibilities of retake in case of permanent assessment

not applicable

Extra information on the examination methods

- Written examination to evaluate the knowledge and insight,
- and oral examination to evaluate insight in the matter.
- Open book written examination : problems

Calculation of the examination mark

Periodic evaluation 75%

Permanent evaluation : 25%