Faculty of Science

FYST95, Physics: Theoretical Nuclear Physics, 7.5 credits

Fysik: Teoretisk kärnfysik, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by The Education Board of Faculty of Science on 2024-12-12. The syllabus comes into effect 2024-12-12 and is valid from the autumn semester 2025.

General information

The course is a elective course in the second cycle for a degree of Bachelor of Science/Master of Science with a specialisation in physics.

Language of instruction: Swedish and English
If needed the entire course is given in english.

Main field of study	*Specialisation*
Physics	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

The overall aim of the course is that the student will have acquired knowledge of the properties of atomic nuclei and insight into how they are theoretically modelled. This includes general knowledge of quantum many-body theory and the ability to apply it to systems consisting of interacting particles. The aim of the course is also to develop the ability to understand the content of research articles dealing with theoretical modelling of quantum systems.

Knowledge and understanding

On completion of the course the student shall be able to:

- explain central models in nuclear physics
- analyse different models in nuclear physics and explain their possibilities and limitations

- explain how nucleon interactions can be used to obtain descriptions of the properties of atomic nuclei
- describe phenomena such as deformed and superfluid nuclei from a modelling perspective.

Competence and skills

On completion of the course the student shall be able to:

- decide which calculation models are appropriate to use in different situations
- perform advanced calculations with some different models
- use mean-field models to describe deformed atomic nuclei
- use the quasiparticle formalism to describe superfluidity
- perform calculations using creation and annihilation operators.

Judgement and approach

On completion of the course the student shall be able to:

- discuss the essential information in simple scientific articles in the subject area.

Course content

The course covers theoretical models for description of properties of the atomic nucleus. Creation and annihilation operators, symmetries and properties of the nucleon-nucleon interaction, mean-field modells (Hartree-Fock), many-particle wavefunctions (Slater, Bogoliubov determinants, Fock space), coupling of angular momenta (Clebsch–Gordan coefficients), collective models, theory of superconductivity (BCS-theory), symmetry restoration and scattering theory. Some topics of current interest like rapidly rotating nuclei and nuclei far from the beta-stability line are introduced.

Course design

The learning activities are composed of lectures and exercise sessions. In addition, there are mandatory hand-in problems.

Assessment

Examination takes place in the form of oral exam at the end of the course. For the oral exam, the compulsary components must be completed.

Students who do not pass a regular assessment will be offered another opportunity for assessment soon thereafter.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction

For passing grade it is needed to pass the examination and hand-in problems.

The grading scale for the oral exam is Fail, Pass, Pass with Distinction.

The final grade is determined by the grade on the oral examination.

Entry requirements

Admission to the course requires 75 credits in physics and 45 credits in mathematics, or a scientific or Degree of Bachelor of Science - in both cases including knowledge equivalent to

- FYSB22 Physics: Basic Quantum Mechanics, 7.5 credits
- FYSC22 Physics: Nuclear Physics, 7.5 credits

In addition, knowledge equivalent to FMFN01/FYSN27 Physics: Quantum Mechanics, 7.5 credits, is required.

General entry requirements and English 6/B.

Further information

The course replaces FYST11 Theoretical Nuclear Physics, 7.5 credits and cannot be credited in a degree together with this.

The course is in its entirety given together with FMFN16, Theoretical Nuclear Physics, 7.5 credits, which is a course at the Faculty of Engineering (LTH).

The course examination is scheduled in accordance with the LTH exam schedule.

The course is given by the Department of Physics, Lund University.