LUNDS UNIVERSITET
Lunds Tekniska Högskola

Course syllabus

Avancerad kärnfysik
Advanced Nuclear Physics

FKFN40, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED F/Pi
Date of Decision: 2023-04-18

General Information

Elective for: F4
Language of instruction: The course will be given in English

Aim

The course covers theoretical models for the structure and reactions of atomic nuclear, as well as experiments in nuclear physics and their scientific applications. The course also includes computer and experiment laboratory exercises in order to introduce the students to methods used in modern nuclear physics. The purpose of the course is to enhance the student's knowledge of theoretical and experimental nuclear physics.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- be able to explain the structure of atomic nuclei with quantum mechanical models
- be able to explain various types of nuclear reactions and transitions
- be able to explain models of atomic nuclei and experimental methods used to study them and describe their limitations
- be able to clarify the connection of theoretical and experimental methods used in nuclear physics.

Competences and skills
For a passing grade the student must

- be able to use quantum mechanical descriptions of atomic nuclei and their properties
- be able to clarify and describe current nuclear physics research

- be able to identify key experiments to investigate selected nuclear phenomena.

Judgement and approach
For a passing grade the student must

- be able to show an ability to assess the applicability and limitations of physical models of nuclear structure and reaction
- be able to independently evaluate and assess the need to acquire further knowledge
- be able to analyze nuclear data and carry out computer programming relevant for such work
- be able to evaluate experimental methods, configurations and results
- be able to relate nuclear physics to other areas of physical sciences.

Contents

The course covers theoretical models for nuclear structure and reactions, as well as experimental set-ups for the study of atomic nuclei, according to the following summary:

- the connection between microscopic and macroscopic properties of atomic nuclei, e.g., shell structure and modes of deformation,
- definitions of, and calculations using, operators for different nuclear transitions,
- experimental methods to probe nuclear properties, e.g., with gamma-ray spectroscopy,
- relations between reaction cross sections and the properties and internal structure of atomic nuclei,
- descriptions of nuclear reactions, such as transfer and knockout reactions, and experimental set-ups to study atomic nuclei with these,
- the application of nuclear structure and reaction models, and related experimental results, in adjacent fields, in particular, nuclear astrophysics and the creation of the elements.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
Assessment: The examination consists of theoretical hand-ins and laboratory reports during the course, and an oral examination at the end of the course. The oral examination is only offered to those students that have passed the written assignments.

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.

Parts
Code: 0123. **Name:** Oral Examination.
Credits: 3,5. **Grading scale:** TH. **Assessment:** Passed exam.
Code: 0223. **Name:** Laboratory Exercises and Reports.
Credits: 2. **Grading scale:** UG. **Assessment:** Passed laboratory exercises and reports.
Code: 0323. **Name:** Computer Exercises and Assignments.
Credits: 2. **Grading scale:** UG. **Assessment:** Passed computer exercises.

Admission

Assumed prior knowledge: FAFF11 Applied Nuclear Physics and Accelerators.
The number of participants is limited to: No
The course overlaps following course/s: FYSC12, FKF021, FKFN20

Reading list

- Krane, K.S.: Introductory Nuclear Physics. John Wiley & Sons, 1988, ISBN: 0-471-80553-X.
- Laborationshandledningar/Guides to laboratory work. Distribueras av institutionen.
- S.G. Nilsson and I. Ragnarsson: Shapes and Shells in Nuclear Structure. Cambridge Press, 1995, ISBN: 9780521019668.

Contact and other information

Course coordinator: Andrea Idini, andrea.idini@matfys.lth.se
Course coordinator: Joakim Cederkäll, Joakim.Cederkall@nuclear.lu.se
Course homepage:
http://www.nuclear.lu.se/utbildning/valfria_kurser/foerdjupningskurs_i_kaernfysik/
Further information: The course is given by the Faculty of Science and does not follow the study period structure. The teaching consists of plenary lectures, group tuition, and supervision in connection with laboratory sessions and associated computer exercises. The lectures are mainly devoted to an overview of the theoretical content, experimental setups and results, including topics relevant for the laboratory sessions, and presentation of contemporary research. The lectures are accompanied by group tuition and compulsory individual problem-sheet hand-ins. The laboratory sessions involve preparatory meetings, laboratory work including computer exercises, feedback sessions, and written reports. Participation is compulsory and graded separately from the front lecture part of the course. It is mandatory to attend the introductory meeting, alternatively the first lecture, or inform the course responsible in order to be admitted to the course.