SH2011 Theoretical Nuclear Physics 6.0 credits

Teoretisk kärnfysik

This is a translation of the Swedish, legally binding, course syllabus.

Establishment

The official course syllabus is valid from spring semester 2027 as decided by the Director of First and Second Cycle Education. Decision date:2026-08-14

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Physics

Specific prerequisites

English B / English 6

Intended learning outcomes

The course gives an introduction to different models of theoretical nuclear structure physics. The aim of the course is to provide understanding of the fundamental excitations and decays

of atomic nuclei from a microscopic point of view and give capability to perform simple calculations.

Course contents

- Nuclear force and second quantization
- Fundamental coupling schemes
- Basic excitations in atomic nuclei and collectivity
- Nuclear deformation
- Magnetic resonances and medical applications
- Normal product and the Wick theorem
- Tamm-Dankoff & Random Phase Approximations
- Nuclear shell model, seniority and computation
- Fission, fusion and nuclear energy
- Nuclear astrophysics and nucleosynthesis

Key words: Central forces, spherical tensors and angular momentum coupling by means of 3j, 6j and 9j symbols. The one particle potential, one particle excitations and the effect of polarization (concept of effective charge). Two-body forces and excitations in two-body systems. Anisotropic harmonic oscillator and the Nilsson model. The cranking approximation, the Inglis formula and determination of the moment of inertia. Quasispin and derivation of the BCS-equation. Second quantization, Wicks theorem, the self consistent Hartree-Fock potential and Hartree-Fock-Bogolyubov approximation. The Tamm-Dankoff (TDA) and Random Phase Approximation (RPA). Broken symmetries and separation of spurious modes by means of the RPA. Restoration of broken symmetries and particle number projection.

Examination

- TEN1 - Examination, 6.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

If the course is discontinued, students may request to be examined during the following two academic years.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.

- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.