ED2235 Atomic Physics for Fusion 6.0 credits

Atomfysik för fusion

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

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

Establishment

Course syllabus for ED2235 valid from Autumn 2009

Grading scale

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

Education cycle

Second cycle

Main field of study

Electrical Engineering,Engineering Physics,Physics

Specific prerequisites

Required background: Basic mechanics and electromagnetic theory, introductory modern physics (SH2008 or equivalent).

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

The research and development of controlled fusion involves knowledge and methods from many different branches of physics, such as electromagnetism, plasma physics, nuclear physics, atomic physics, surface physics and materials physics.

The purpose of this course is to make the student familiar with those aspects of atomic physics that are most important in fusion research. The focus of the course is on basic understanding of atomic collisions and applications in plasma modeling, plasma diagnostics and plasma surface interactions. Much of the course content is applicable also in other contexts in plasma processing and technology, ion implantation and radiation effects.

Course contents

Short review of quantum mechanics and atomic structure. Collision kinematics, cross sections, rate coefficients. Elastic collisions, classically and in wave mechanics, the Born approximation. Interatomic potentials. Thomas-Fermi model. A universal interatomic potential. Plasma resistivity, stopping power, sputtering and backscattering at surfaces. Inelastic collisions classical- and Born approximations. Electron impact ionization and excitation, recombination, electron transfer, bremsstrahlung. Semi-empirical fits and Effective Z, power balance, thermal equilibria, interplay of ion transport and atomic processes. Numerical exercises with MATLAB, involving rate coefficients, penetration of impurities in plasmas, emissivity profiles and neutral particle transport, etcetera.

Disposition

Individual and group assignments and one written exam.

Course literature

R.E. Johnson, Introduction to Atomic and Molecular Collisions

Excerpts of D. Park, Introduction to the Quantum Theory, 3rd ed. 1991, R.D. Cowan, The Theory of Atomic Structure and Spectra, J.F. Ziegler, J.P. Biersack and U. Littmark, The Stopping and Ranges of Ions in Matter Vol. 1 or similar literature.

Selected journal papers. Lecture notes.

Examination

- ANN1 - Assignments - Individual, 1.5 credits, grading scale: A, B, C, D, E, FX, F
- ANN2 - Assignments - Group, 1.5 credits, grading scale: A, B, C, D, E, FX, F
- TEN1 - Written exam, 3.0 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.

Other requirements for final grade

Having followed this course the student should:

· Understand basic atomic collision physics in terms of the dominating mechanisms in physical processes like elastic collisions, electron impact ionization and excitation, and charge transfer.

· Be able to exercise intuitive judgment of the relevant orders of magnitude, time scales, energy dependencies and similar in atomic collisions with fusion relevance.

· Be able to account for the role of atomic collisions in fusion plasma physics and plasma surface interactions.

· Be familiar with the use of fitting formulae and databases for cross sections, rate coefficients and derived quantities like stopping power or sputtering yield.

· Be able to use atomic data in numerical modeling.

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.