FED3210 Motion of Charged Particles, Collision Processes and Basis of Transport Theory I 6.0 credits

Laddade partiklars rörelse, kollisionsprocesser och grundläggande transportteori I

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

Establishment

Course syllabus for FED3210 valid from Spring 2012

Grading scale

G

Education cycle

Third cycle

Specific prerequisites

Language of instruction

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

Intended learning outcomes

When completing the course, the student should be able to:

Describe particle motion in terms of drift motion of guiding centre,

Understand the concept of adiabatic invariants. Stochastisation of orbits by asymmetries.

Know how to use Poincaré plots and standard mapping for analysing regular and stochastic orbits, Chirikov criterion for determining stochastisation, and KAM surfaces. Understand how Coulomb collisions affect the motion of single particles and how relaxation towards isotropic thermal plasmas takes place.

Be familiar with the concept of stochastic differential equations and how to use it for solving diffusion equations. The most important collision processes in plasma including nuclear reactions.

Understand the basis of curvilinear coordinate system: covariant and contra variant representation, differentiation in curvilinear coordinate system, flux coordinate system, Clebsch representation of magnetic field and coordinate system suitable for analysing guiding centre motion.

Understand the basis of classical mechanics: Lagrange equation, Hamilton equation, canonical transformation, cyclical coordinates, action-angle variables, Lagrange and Hamiltonian equations of motion of charged particles.

Course contents

Perturbation theory of charged particle motion and adiabatic invariants. Drift motion of guiding centre. Stochastisation of the orbits by asymmetries, Poincaré plots, Chirikov criterion. Collision processes. Relaxation processes by Coulomb collisions with a background plasma. Interactions by time dependent fields (including wave-particle interactions; resonance interactions) superadiabatic oscillations, collisionless absorption and stimulated emission processes. Brownian motions – Monte Carlo methods for describing particle motion. Curvilinear coordinate system with application to charged particle motion. Basis of analytic mechanics with application to charged particle motion in curvilinear coordinate system.

Disposition

Seminars or discussion meetings.

Course literature

Lecture notes. Research articles refered to in the lecture notes for understanding the notes.

Parts of the following, or similar, litterature:

P. Helander and D.J. Sigmar Collisional Transport in magnetized Plasma Introduction 1-13, Collision operator 22-58, 99-136, adiabatic invariants 99-117 with Lagrange and Hamiltonians.

D.J. Rose and McClark, Plasma and Controlled Fusion, M.I.T. and Wiley, New York-London 1961, p. 13-53, 228-256.

L. Spitzer, Physics of Fully Ionized Gases, second rev. Ed., New York, 1962, 120-154.

P. Rutherford and Goldstone Poincaré plot and Chirikov criterion. The subject is also included in Chap. 11 in Classical mechanics, Goldstein (Third Edition 2001).

Curvilinear coordinate system. R. B White, Ch. 1.,

E. Madelung Die Mathematischen Hilfsmittel des Physikers, p 212-220 or corresponding content in any other classic text book,

Classical mechanics, Goldstein Chapters corresponding to the lecture notes. Ch 8-10 in Third Edition, Addison Wesley, San Fransico 2002.

Stochastic differential equations Numerical Solutions of Stochastic Differential Equations, P. E. Klueden and E. Platen, Springer-Verlag, Berlin 1992, Introductory chapter XX-XXXV

Examination

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.

Other requirements for final grade

Final writen and oral exam.

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.