FJD3300 Kinetic Plasma Theory 6.0 credits

Kinetisk plasmateori

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

Establishment

Course syllabus for FJD3300 valid from Autumn 2018

Grading scale

G

Education cycle

Third cycle

Specific prerequisites

Master in Electrical Engineering or Engineering Physics or similar.

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

- Derive the basic plasma kinetic equation from first principles

- Discuss applications and validity of the Vlasov and Boltzmann equations
- Describe and explain Landau damping and the two-stream instability
- Describe basic kinetic properties of hot magnetised plasmas
- Derive and explain the Fokker-Planck equation
- Describe basic relaxation processes and collision times
- Distinguish between fully kinetic, drift kinetic, hybrid and gyrofluid models

Course contents

Liouvilles theorem. BBGKY hierarchy. Vlasov and Boltzmann equations. Plasma dispersion function. Landau damping. The bump-on-tail instability. Criteria of Nyquist and Penrose. Bernstein modes. The Fokker-Planck equation. Relaxation times. Resistivity. Chapman and Enskog expansions. Drift-kinetic model. Gyrokinetic model. Gyrofluid model. Vlasov-Fluid hybrid model. Two-stream instability. Inverse Landau damping. Collisionless drift waves. Electron and ion temperature gradient instabilities. Loss-cone instability.

Disposition

Students and teacher meet for four course sessions. These two hour-sessions start with a short introductory lecture by the teacher on the corresponding part of the course. Remaining time is used for discussion on topics that the students bring up. The students should, before each course meeting, study the literature and bring five relevant questions for group discussion.

At the end of the course the student should complete a home assignment in the form of written answers to a set of detailed questions on each part of the course. Having done this satisfactorily, the student should pass an oral exam related to the written assignment.

Course literature

Selected pages from the following books (for details see separate ”Contents” document):

• T. J. M. Boyd and J. J. Sanderson, The Physics of Plasmas, Cambridge University Press, 2007.

• F. Chen, Plasma Physics and Controlled Fusion, Plenum Press, 1985.

• R. O. Dendy, Plasma Dynamics, Clarendon Press, 1994.

• R. J. Goldston and P. H. Rutherford, Introduction to Plasma Physics, IOP Publishing Ltd, 1995.

• P. Helander and D. J. Sigmar, Collisional Transport in Magnetized Plasmas, Cambridge University Press, 2002.

• S. Ichimaru, Statistical Plasma Physics, Volume I: Basic principles, Westview Press, 2004.

• D. G. Swanson, Plasma Kinetic Theory, CRC Press, 2008.

• W. Stacey, Fusion Plasma Physics, Wiley, 2012.

• J. Wesson, Tokamaks, Clarendon Press, Oxford, 1997.

Journal articles on topics not covered in books will be added.

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

Participation in group discussions, completion of home assignments 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.