Announcement

Plasma Physics: Fundamentals
PD Dr. Emanuele Poli

Description

Plasmas are ionized gases and are sometimes denoted as the fourth state of matter. The plasma state dominates the visible universe; moreover, high-temperature plasmas are studied in laboratory experiments with the goal of understanding and reaching the conditions for safe, clean and potentially unlimited production of electricity from nuclear fusion reactions. From the point of view of fundamental physics, plasmas offer a unique opportunity to study a statistical system dominated by electromagnetic interactions. Describing the fundamental principles that govern the dynamics of high-temperature plasmas is the goal of this course.

Learning Outcomes

Students who have concluded this course successfully possess the basic physics knowledge needed for a description of astrophysical and fusion plasmas.

Content

1) Introduction to Plasma Physics:
   - Examples of plasmas in nature and laboratory
   - Basic properties of plasmas and their classification
   - Ionisation degree of a plasma
2) Single-particle motion:
   - Gyration in a homogeneous magnetic field
   - Drifts perpendicular to an inhomogeneous field
   - Mirror force
   - Adiabatic invariants
3) Continuum description:
   - Derivation of the fluid equation
   - Maxwell equations in plasma physics
   - Equation of ideal magnetohydrodynamics (MHD)
   - Diffusion, dissipation and production of magnetic fields
4) Waves in homogeneous plasmas:
   - Waves in a single-fluid (MHD) description
   - Waves in a two-fluid description
5) Kinetic theory:
   - Derivation of the kinetic equation
   - Fokker-Planck equation and Coulomb collisions
   - Landau damping of Langmuir waves
6) Radiation processes:
   - Derivation of the Larmor formula
   - Examples of radiation processes and their importance in fusion experiments.

Prerequisites

Basic electrodynamics

Literature

- Lecture notes prepared by the lecturer, including further references, in particular
- U. Stroth, Plasmaphysik, Vieweg+Teubner 2011
- I. H. Hutchinson, Principles of Plasma Diagnostics, Cambridge 2005
Additional Information

Lectures (3 SWS) plus class exercises (2 SWS). Oral examination (details are communicated by the lecturer at the beginning of the course).

Lecturer

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