# Plasma Physics I, Fundamentals

## *Waves, Instabilities and Turbulence*

**Description**

Plasmas are ionized gases dominated by electromagnetic interactions. Much of the matter in the universe exists in the plasma state. On Earth, laboratory plasmas are studied in view of industrial applications and because of the possibility of generating electrical energy through controlled nuclear fusion reactions. This course introduces the fundamental notions for a theoretical description of high-temperature plasmas, from single-particle motion to fluid and kinetic approaches, substantiating them with numerous examples from astrophysics and magnetic-fusion research. A particular focus is given to waves and instabilities that can generate turbulence and thus induce transport of particles and heat. In this framework, the fundamentals of turbulent dynamics and stochastic transport are reviewed.

**Content**

- Basic properties of the plasma state.
- Single-particle motion, fluid and kinetic description of plasmas.
- Plasma waves and resonant processes; plasma heating.
- Linear theory of plasma instabilities.
- Fundamentals of turbulence theory.
- Application to magnetized plasmas: turbulent transport and basic description of stochastic processes.

**Prerequisites**

Basics of electrodynamics and classical mechanics.

**Additional Information**

Lecture with exercises, 6 ECTS credits. Lecture notes available, including suggestions for further reading. Oral examination.

**Lecturer**

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