# Introduction to Space Physics and Instrumentation / Fall 2015 (EAS 4360 / 6360)

## Lecturer:

Sven Simon (room ES&T 2232, email: sven.simon@eas.gatech.edu)

## Lectures:

Tuesday and Thursday, 09:30-11:00, room L1175

## Requirements:

- very good knowledge of classical electrodynamics, vector calculus and differential equations
- relevant courses at GT: MATH 2401 (Calculus III) and PHYS 2212 (Electrodynamics)

## Grading of this course:

- **40%:** Weekly homework assignments (to be returned one week later). Late submissions are not accepted without prior authorization.
- **20%:** Short presentation (literature review, 15 minutes) on a subject from the field of space plasma physics at the end of the term. No written report is required.
- **20%:** Mid-term exam (tentative date: 08 October, during class).
- **20%:** Final exam (during final's week)

**Topics to be covered:**

**1. Introduction: The scope of space physics**

***Part 1:*** *Fundamentals of Space Plasma Physics*

**2. Characteristics of a plasma**
(Debye length, plasma frequency, collective behavior, examples)

**3. Single-particle motion**
(particle dynamics in constant and inhomogeneous electromagnetic fields, adiabatic invariants, magnetic mirror, trapped particles, radiation belts, ring current)

**4. Kinetic plasma theory**
(distribution function in phase space, Vlasov's and Boltzmann's equations, description of collisional plasmas, typical phase space distributions in space plasmas, loss cones, Kappa distribution, measurements of the distribution function)

**5. Multi-fluid description and magnetohydrodynamics**
(limits of validity, moments of the distribution function and of Vlasov's equation, multi-fluid and magnetohydrodynamic description, frozen-flux theorem, magnetic pressure and magnetic tension, convection and diffusion, magnetic Reynolds number)

***Part 2:*** *Plasma Processes in the Solar System*

**6. The solar wind**
(structure of the heliosphere, Parker's solar wind model, magnetic field of the Sun and interplanetary magnetic field)

**7. Introduction to space instrumentation**
(Debye sheath and Langmuir probe, ground-based measurements of ionospheric densities, particle detectors, magnetometers, imaging of energetic neutral atoms)

**8. Planetary magnetospheres**
(concept and structure of Earth's magnetosphere, magnetospheric and ionospheric current systems, magnetic reconnection, open magnetosphere and Dungey cycle, magnetic storms, magnetospheres of other solar system bodies)

**9. Planetary aurora**
(generation of Earth's aurora, diffuse and discrete aurora, acceleration region and Knight's theory, aurora at other solar system bodies)