SpaceMaster

Activities in Kiruna

The Department of Space Sciences at Luleå University of Technology organizes the education in collaboration with the Umeå University, the Swedish Institute of Space Physics (IRF), EISCAT Scientific Association and the Swedish Space Corporation (SSC) Esrange Launch Site.

General SpaceMaster Structure

Semester 1	All students at JMUW taking core modules and optional modules in languages and Bavarian culture.					
Semester 2	All students at LTU, Kiruna Campus, taking core modules and optional modules in languages and Sámi culture.					
Semester 3	CU Track E1	CTU Track E5	HUT Track E2	JMUW Track E3	LTU Tracks E4, S3	UPS Tracks S1, S2
Semester 4	Work on the Master Thesis. Supervisors from two Institutions.					

1. First Semester, Core Modules, 30 ECTS, at JMUW, Germany

The modules to be taken by all students will be:

1. Introduction in Space Physics (7.5 ECTS)
2. Spacecraft System Design (7.5 ECTS)
3. Space dynamics (7.5 ECTS)
4. Programming, Embedded Control, Communication (7.5 ECTS)

(Each module is structured as 4 hours per week, equivalent to 7.5 ECTS credits, giving a total of 30 ECTS).
Solar wind, solar activity, shock waves, particle acceleration.

2. Second Semester, Core modules, 30 ECTS at LTU, Sweden

The modules to be taken by all students will be:

1. Spacecraft Environment Interaction (7.5 ECTS).
2. Electronics in Space (7.5 ECTS).
3. Image Processing and Remote Sensing (7.5 ECTS)
4. Optics- and Radar-based Observations (7.5 ECTS)

Complementary language tuition as outlined in section 2.17 will be available. In addition, events to experience the Sámi culture will be arranged.

Module Descriptions

Spacecraft Environment Interactions (7.5 ECTS)

In the course you learn about the environment that the spacecraft encounter, and also about how that environment interacts with the spacecraft with its instruments. You also learn about the methods that are used to overcome harmful effects on the spacecraft by its environment. The spacecraft, often a satellite, is in vacuum, leading to outgasing of particles from the spacecraft resulting in a risk of contamination of sensitive surfaces. The spacecraft is in an extreme thermal environment, with cold space and warm sunshine, to which it must adopt itself. It is also exposed to other types of high energetic radiation of corpuscular or continuous form, which can affect solar panels and electronics. The spacecraft also has a risk of colliding with micrometeoroids and orbital debris. In lower orbits there is a risk of collision with different molecules, which can induce chemical reactions on the surface of the spacecraft or simply slow the spacecrafts velocity down. The spacecraft has also a risk of being electrically charged by the plasma that is in the space, with a following risk of sudden electrostatic discharge or affection on instruments.

Electronics in Space (7.5 ECTS)

The course aim is to give the student an understanding of the hazards and problems that electronic circuits and components face in space and how these hazards and problems may be overcome. Also space radiation, design of semiconductor devices, materials, total doze, ionisation, EMC and testing techniques in space will be covered in the course.

Image Processing and Remote Sensing (7.5 ECTS)

The aim of the course is to give an understanding of basic concepts and techniques in remote sensing and digital image processing for space applications. Basic concepts: Electromagnetic spectra, spectral signatures, satellites, sensors, geometric and radiometric resolution, interactions in the atmosphere. Pre processing: System correction, radiometric correction, geometric correction, deconvolution. Image enhancement: Contrast manipulation, filtering, colour composites, principal analysis etc.
Digital classification. Space applications (aurora images, astronomy, environmental monitoring from space). File formats. Image compression and coding.

Optics- and Radar-based Observations (7.5 ECTS)

The aim of the course is to give understanding of the principles for ground based systems making observations in the Earth´s atmosphere and ionosphere. One of the receiver stations of the European Incoherent Scatter (EISCAT) radar is located in Kiruna. The students will get a chance to run the radar and analyse the data. Even other instruments in Kiruna are presented such as the optical network ALIS, the ESRAD radar and the IRF lidar. Course content: Radiometry, fundaments of absolute optical measurements, photometers, low-light spectroscopic imaging systems, spectrometers, interferometers, lidars, mm-wave techniques, and radiometers. Types of radars and applications: power and range equations. pulsed radars, doppler pulsing, CW-radar, tracking and scanning radars, antennas, SAR-radar and incoherent scatter radar with applications.

3. Third Semester

During the Third Semester there are optional Tracks at different universities. The students will earn 30 ECTS at each institution. There may be some students that spend the 3rd Semester at TWO institutions. The 30 ECTS is recognised by all universities.

The different tracks during the Third Semester are:

E1 Engineering Track 1
E2 Engineering Track 2
E3 Engineering Track 3
E4 Engineering Track 4
E5 Engineering Track 5
S1 Scientific Track 1
S2 Scientific Track 2
S3 Scientific Track 3

E4: Engineering Track 4, 30 ECTS, LTU, Sweden – Space Technology and Instrumentation

The modules will be:

1. Space Vehicle Systems (7.5 ECTS)
2. Principles for Space Instruments (7.5 ECTS)
3. Instrument design and measurement techniques for spectroscopic imaging (7.5 ECTS)
4. Balloon project BEXUS at Esrange (Could be part of the Thesis work)
5. The Rocket Project REXUS at Esrange (Could be part of the Thesis work)

Module descriptions

Space Vehicle Systems (7.5 ECTS)

Description: The aim of the course is to give an overview of space vehicle systems related to launchers, satellite design and space project management. Topics covered are sounding rockets, launchers, propulsion, launch and spacecraft trajectory calculations. Students are given a rare opportunity to work on various space projects to get a first hand training in project management, system verification and testing. During the course the students work on a nano satellite group design project. The objective of the project is to build and test a nano satellite to meet the given design specifications. The satellite should build to such a standard to survive the drop test and the IRF thermal vacuum chamber test.

Principles for Space Instruments (7.5 ECTS)

Description: The course gives information of the state of the art of sensors and instruments used in observational and experimental space physics including physics principles, advantages, disadvantages and platform requirements. Also included is how space science projects are designed and selected. The major part of the course is devoted to instruments for in-situ measurements from satellites, sounding rockets and balloons, but ground-based measurement methods are also covered.

The teaching is a combination of lectures by a number of specialists and two group assignments. The first group assignment involves analysis of a satellite project proposal, the second one is to design a satellite instrument project and write and present a proposal. There is also one practical about computer simulation of a particle instrument.

Instrument design and measurement techniques for spectroscopic imaging (7.5 ECTS)

Description: The course will give an introduction to instrument design and measurement techniques for spectroscopic imaging in observations of various optical phenomena in space physics such as aurora, artificial airglow and meteors. The contents of the course: Scientific requirements, why bother with all this?, imaging darkness, spectrocopic imaging, etc., Imaging detectors: (IPD), CCDs, image intensifiers, (CMOS sensors), filters, interference filters, (Fabry-Perot etalon), optical systems for spectroscopic imaging, instrument design, basic radiometry, SNR estimations, overview of image processing, absolute optical measurements, calibration techniques: (light standards, integrating spheres), actual spectroscopic imaging systems: ALIS, and others, planning and preforming an observation with ALIS (Aurora/Meteors/RIOE (radio induced optical emissions)/calibration - if weather permits otherwise analyse old data), doing the initial data-analysis (image reductions)

Balloon project BEXUS at Esrange

Description: The Swedish Space Corporation (SSC) offers the students at the Space Campus a unique opportunity to design, build and fly their own experiments on stratospheric balloon platforms launched from Esrange. The launches are planned to occur annually in mid or late January (http://www.krm.se/bexus/eng/).

Rocket Project REXUS at Esrange

Description: The Swedish Space Corporation (SSC) and the German Aerospace Center (DLR) offer the students at the Space Campus a unique opportunity to design, build and fly their own experiments on sounding rockets launched from Esrange. The launch in 2004 will took place in October. (http://rexus.krm.se/default.asp?sida=2).

S3: Science Track 3, 30 ECTS at LTU, Sweden – Atmospheric and Space Physics

The modules will be:

- Atmospheric Physics
- Space Plasma Physics
- Solar Physics
- Numerical methods in Space Physics
- Solar System Physics

Module Descriptions

Atmospheric Physics

The aim of the course is to provide an understanding of the physical behavior of the atmosphere. Course contents: Atmospheric composition and structure. Radiation, temperature and stability. Water and clouds. Earth's rotation and the global circulation. Gravity waves, planetary waves and tides. Thunderstorms and the global electric circuit. Ozone depletion and other atmospheric pollution effects. Climate change - natural and anthropogenic factors. The atmospheres of other planets. The teaching is a combination of lectures and laboratory exercises.

Space Plasma Physics

The aim of the course is to deepen the student's understanding of the plasma physics relevant to the magnetosphere and solar system. The contents of the course: Collisionless shocks, plasma instabilities, the magnetohydrodynamics of the Sun, solar wind interactions with magnetised and non-magnetised planets, magnetospheric physics of the planets in the solar system, auroral physics, magnetospheric storms and substorms. The teaching is a combination of lectures, exercise classes and laboratory exercises.

Solar Physics

The aim of the course is to give a basic knowledge of solar physics and deeper knowledge in certain areas including a glimpse of current research in the field. The Sun and its activity. The basics of solar physics. The quiet Sun, its interior and atmosphere. The active Sun, helioseismology, explosions on the Sun, active regions. The solar cycle. The hot corona and the solar wind. The heliosphere. Highlights in modern solar research.

Numerical Methods in Space Physics

Description: The course will give an introduction to numerical methods used in space physics. The students will learn how to solve mathematical problems encountered in space physics using computers. The contents of the course: Basics of scientific computing, numerical methods for solving mathematical problems that frequently arises in physics, such as ordinary and partial differential equations, an overview of common computational problems in space physics, such as the interaction between the solar wind and planets, and exospheric simulations, and the different methods used to solve these problems, such as fluid, particle and hybrid methods, an important part of the course is assignments, where the students will solve computational problems arising in space physics using a suitable programming languages such as Matlab.

Solar System Physics

Description: The aim of the course is to deepen the student's understanding of the solar system. The contents of the course: Fundamental forces, a tour of the solar system, interstellar and galactic forcing, the sun, the planets, interplanetary space, cosmogony – formation and evolution of the planetary system, exoplanetary systems, solar system space research.

4. Fourth Semester

Introduction

The students will do their Master Thesis work valued at a minimum of 30 ECTS during the Fourth Semester.

The European students from CU, CTU, HUT, and UPS will do their Thesis work at their Home University or at Industry or a research institution with close relations to the home university.

Some of the LTU/Kiruna students and the JMUW students will not do their Thesis at their Home University. They will spend the Second year at a Host university depending on choice of Track.

The Third country students will disperse to different Partner universities, dependent on the subject of their research thesis work.

Thesis Work

The Thesis work in France can be performed in Toulouse which benefits from a large support in industry and research institutions. For instance applied thesis could be realised in industries like ALCATEL SPACE or CNES (Centre National des Etudes Spatiales). Research thesis could be realised in the laboratories belonging to Observatoire Midi Pyrénées.

Thesis work at CU can be undertaken on campus, in association with UK space industry (Astrium, Vega), at the RAL laboratory of the research councils or in collaboration with the Open University.

The Thesis work at CTU, HUT and JMUW can be performed around the laboratories at the universities and/or in space related research projects with connection to the universities.

The Thesis work at LTU will be performed around the excellent facilities in the Esrange base in Lapland area, Kiruna, in close collaboration with the European Space Agency ESA and other Space Agencies around the Globe. Some Thesis work will also be done at NEAT- the North European Test Range at Vidsel.

Some of the Thesis work will be integrated projects in tele-robotics, remote operation, sensor data fusion and automatic control where the participating students are located all around Europe.