

## Teaching Planetary Sciences in the Master on Space Science and Technology

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### Abstract

The master on Space Science and Technology, taught now for three academic years in the Faculty of Engineering in Bilbao, UPV-EHU, Spain, is open both to students who aim to work in space industry and to students who intend to pursue an academic career in Solar System Astrophysics. A wide number of electives are offered in order to address the different needs of students. In this poster we describe the path offered to students who intend to follow an academic career in Planetary Sciences.

### 1. Introduction

In Spain, research students are only admitted to a PhD degree if they have been previously awarded a Master with access to the Doctorate. The Master in Space Science and Technology, a one year course comprising 60 ECTS, is designed not only to prepare future space engineers and technologists, but also to give access to a scientific PhD track, and thus it must provide the necessary background for a career in scientific research.

During the first trimester, the students follow eight compulsory subjects, 3 ECTS each, that give them a broad background on Space Science and Technology. From then on, the track of the engineer and that of the future scientist become distinct, since in the second trimester the student has to study seven subjects to be chosen from a total offer of fourteen electives (again 3 ECTS each), and the last few months are dedicated to the master thesis, that accounts for 15 ECTS.

### 1. Compulsory Subjects

The compulsory subjects Astrodynamics and Orbital Motion, Space Physics, Introduction to Space Materials, Optics, Detectors and Sensors, Space Data

Processing and Spacecraft I and II, give the student a wide background of the Science and Technology relevant to Space and the study of the Solar System. In our era of space missions, even the more technologically oriented subjects will be relevant to the future planetary scientist if they get involved in the development of a mission or instrument. On the other hand subjects such as Space Physics, which describes magnetospheres and ionospheres or Astrodynamics have more direct relation to Planetary Sciences, while Space Data Processing and Detectors and Sensors can be extremely useful to students who intend to dedicate themselves to the analysis of experimental data.

### 2. Electives

As we have mentioned, it is the selection of electives that distinguishes a technological track from a scientific track. Students intending to pursue a PhD in Planetary Science have the opportunity of studying a range of subjects that will prepare them thoroughly for future research. Attending mainly to the needs of prospective research students in our group, we offer the following science-oriented electives: Astronomy and Astrophysics, Physics of the Solar System, Relativity, Physics of the Earth's Atmosphere, Interferometry, and Adaptive Optics.



Figure 1: The Aula Espazio Gela, during an outreach event.

### 3. Practical work

The Master is taught in the Aula Espazio Gela, a facility that includes a dedicated room and an observatory located on the roof of the Faculty of Engineering. The Aula is equipped with a computer for each student, which allows the lecturer to include practical exercises in their lecture time. On the other hand, the observatory includes a PlaneWave CDK-20 telescope (20" diameter) able to work from near-UV to mid-IR, resting over a 10Micron GM4000 computer-controlled mount inside a Sirius dome, and a set of three 15cm solar telescopes on a Paramount mount located in a separate roll-off roof shed.

Subjects such as Astronomy and Astrophysics, Space Physics, Physics of the Solar System and Planetary Atmospheres include practical work in the observatory, giving the student the opportunity to familiarize themselves with techniques and instrumentation. Moreover, some of the practical work in Space Data Processing is performed with data obtained directly by the students in the observatory.



Figure 2: The observatory of Aula Espazio Gela, located on the roof of the Faculty of Engineering in Bilbao.

### 4. Master Thesis

The final months of the Master are dedicated to the master thesis, which comprises 15 ECTS credits. In the case of prospective PhD students the master thesis is often their first direct approach to research proper.

Although most of our students choose a technological track, every year there is an offer of projects related to Planetary Sciences, since one of the main objectives of the Master is to prepare future Planetary Science scientist. The master was taught for the first time in 2009, and up to now only two classes have graduated. In these two years, four students chose scientific subjects for their master thesis:

- Planetary Photometry from the Aula Espazio Gela Observatory.
- Study of Venus south dipole in VIRTIS images from the Venus Express spacecraft.
- Development of Software for the analysis of images obtained with the VCM camera onboard Venus Express.
- Development of Software for the automatic detection and analysis of impacts on video observations of Jupiter.

The first two have joined our group as PhD students.

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