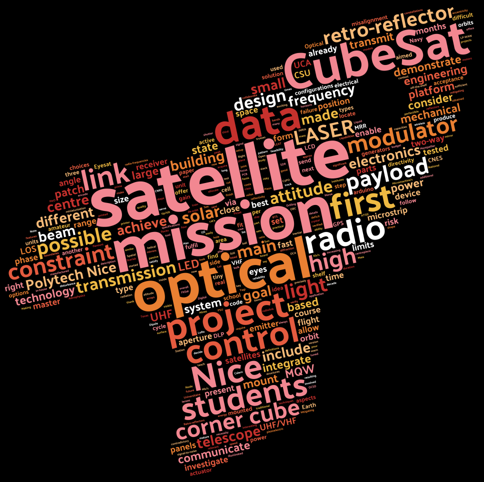
MASTER IN ASTROPHYSICS

Build a nanosatellite!



SUMMARY.

Have you ever thought of building an artificial satellite yourself? It is now more than 60 years that the first artificial satellite, Sputnik, was set into orbit around the Earth. This satellite served as an inspiration of generations of researchers and engineers to develop the technologies of aeronautics and space, which are nowadays very commonly found in everyday life (telecommunications, localisation, computers, materials, etc.).

This METEOR aims at giving a glimpse of spacecraft physics and bringing space technologies notions to the hands of students in the form of short courses, and a direct contribution to the *Nice Cube* project, the nanosatellite project of Université Côte d'Azur, which will demonstrate a LASER link between the ground and the satellite.

OBJECTIVES

Today, it is possible to test and validate scientific ideas and new technologies in space on small timescales (less than 5 years). This can be done aboard tiny satellites called "CubeSat". These are standardized satellite platforms made of cubes of 10 cm side and 1 W of available electrical power (1U format). Several cubes can be combined (2U, 3U, etc.). Such a platform enables motivated students to learn on a hands-on project the technologies, project management, and all the space-related competences. In this METEOR, the student will first follow courses on space technologies. They will learn how to read a scientific or technical article, and then they will work on a hands-on project related to the mission in development in Nice, called *Nice Cube*.

What you will acquire:

- After this METEOR, you will be aware of nanosatellites space missions particularities and know where to find relevant information of a space mission development. You will know how to read a scientific or technical article and extract its main information to raise your understanding level of a topic. You will have a first experience on a real mission, *Nice Cube*.
- You will acquire basic knowledge of the physics of spacecrafts (positioning, orbits, orientation). You will also learn the essentials of space project management, that you will practice on one focused aspect of space missions.

PREREQUISITES

To follow this METEOR you will need to have good basics of general physics, to understand spacecraft dynamics (notions of basic mechanics, but also dynamics), wave propagation in different media (electromagnetism) and have basic knowledges of signal processing.

THEORY

Introduction to optical communications. Using light to transmit a message has been done for ages. The same principle is nowadays used to improve inter-satellite communications. Principles of free space optics, light propagation in different media, issues and solution for free space optical communications will be reviewed in this course.
by F. Millour

Orbital dynamics notions - impact on orbits choice. The Keplerian model for a setallite's orbit is not a valid approximation in the complex Earth environment. The main orbit perturbations will be reviewed, and their impact on the orbital dynamics. We will deduce from that the criteria to use in order to choose a best-suited orbit for a satellite mission.
by G. Metris

Satellite Attitude Determination and Control System (ADCS). This course is an introduction to the fundamental concepts that are necessary to design an attitude control system, which aims at orienting the satellite in a pre-defined position. After a brief glance at the most-commonly used hardware for ADCS, a mathematical approach on the control problem will be developed.
by L. Dell'Elce

Global Navigation Satellite Systems (GNSS). GNSS such as GPS, GLONASS, Galileo are key components of modern terrestrial space missions. This course first reviews the basics concepts of GNSS precise positioning. A more practical session covers the main steps of the GNSS processing chain: from data acquisition with a GNSS device to the final position. We finally discuss the limitations of GNSS navigation in terms of precision and accuracy.
by L. ROLLAND

Project management. Space-related matters on project management. Organization, project follow-up, tools.
by S. OTTOGALLI

APPLICATIONS

by F. MILLOUR, L. DELL'ELCE, L. ROLLAND

The students will work on a short project during 1 month (4 weeks). This assignment will be directly related to the *Nice Cube* mission being developed at Université Côte d'Azur. These mini-projects contain a theoretical part and a practical part, and depend on the needs of the Nice Cube project. Example projects titles are: "Space mechanics", "Optical communications", "Precise Orbit positioning with GPS/GNSS".

MAIN PROGRESSION STEPS

For instance :

- First and second week: theoretical courses (5 topics) and bibliographic study with presentation of a paper.
- Week 3-6: mini-project related to the Nice Cube mission.
- Last week : preparation of the final oral presentation.

EVALUATION

The evaluation of the nanosatellite METEOR is progressively distributed as follows:

- Theory (30%): articles summary exercise (written) and short oral presentation,
- Practice (30%): at mid-course, first version of the report submitted for feedbacks. The behavior during the mini-project (oral reporting of the weekly work, attitude, motivation) will be positively evaluated.
- METEOR defense (40%): mini-project evaluation by the MAUCA jury

BIBLIOGRAPHY & RESSOURCES

Nice Cube project
PICsat project webpage

CONTACT

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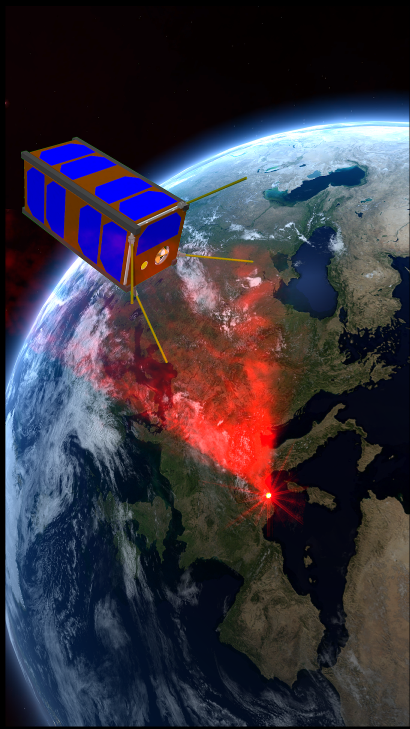

The Nice Cube mission