Thesis subject

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Title of the thesis subject : **Characterising the internal structure of asteroids using electromagnetic imaging techniques**

Description of the thesis subject :

In November 2014, the European Space Agency's Rosetta mission encountered comet 67P/Churyumov-Gerasimenko. One of the instruments on this mission is the CONSERT radar. CONSERT explored the nucleus of this comet using electromagnetic waves in the radio wave regime by exploiting a bistatic configuration. One of its scientific objectives is to contribute to a better understanding of the composition of the cometary nucleus and its internal structure. CONSERT was the first instrument of this type and demonstrated the ability of these electromagnetic techniques to explore the interior of small solar system bodies (comets and asteroids). As a result, new missions are being prepared to better understand the internal structure of comets and asteroids. In particular, the ESA-HERA mission was launched in October 2024 to study the binary asteroid 65803 Didymos with a radar, called JuRa, on board, and will encounter the asteroid in 2026.
The electromagnetic field after interaction with the asteroid depends on its physical characteristics, so it is possible to use this field to find the asteroid's internal structure and its electromagnetic characteristics. This is achieved by solving an inverse diffraction problem. For our application (comet and asteroid), the main difficulties are due to the very large size of the target and the limited number of measurements available.

In this Phd thesis, we will seek to develop new imaging procedures adapted to this studied case (based on existing ones), so as to extract quantitative information on the internal structure of comets and asteroids from data that can be measured in real space experiments. These procedures will be applied to the JuRa radar, which will probe the Didymos asteroid, to prepare for the exploitation of this radar data. To this end, studies will be carried out on the choice of input parameters, on the most relevant information that can be introduced into these imaging procedures (in particular information provided by other sensors), and on the choice of quantities to be reconstructed. The procedures will be tested with experiments on asteroid analogues carried out in the laboratory, in an anechoic chamber.

The student will benefit from ongoing national and international collaborations with researchers in planetology and applied mathematics.

This thesis will combine theoretical and numerical works in the field of microwaves. The candidate should have a good knowledge of physics, particularly electromagnetic fields. Expertise in the specifics of the microwave field would be a plus.

References :

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