Internal imaging of asteroid analogues using electromagnetic methods

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Abstract

Space has always fascinated humans and for several decades now we have been able to send probes there. In order to better understand the formation of our solar system and, in our case, small solar bodies (asteroids, comets), it is necessary to develop new remote sensing and imaging methods. We seek to image the internal structure of comets and asteroids using radar technique that is widely applied in various other fields (geophysics, medical, etc.). This was the case with the CONSERT (Comet Nucleus Sounding Experiment by Radiowave Transmission) radar on board the Rosetta space mission to comet 67P/Churyumov-Gerasimenko. CONSERT has led to numerous scientific discoveries [1], [2] and has inspired new space missions such as the Hera mission (rendezvous 2026), which will send the Juventas Radar to the binary asteroid 65803 Didymos, in order to carry out a tomographic radar inspection of this system and more particularly of its moon. In order to anticipate the exploitation of the results, adequate imaging techniques must be implemented and tested on equivalent experiments on Earth. To do so, we will use scale of invariant rules and analogues.

For this purpose, we consider two 3D printed models of the asteroid 25143 Itokawa [3]. Both analogues are based on detailed data obtained by exploiting images of the asteroid collected with cameras [4] during the Hayabusa mission [5]. One of the analogues is a homogeneous model with a constant permittivity, while the other, a detailed model, is composed of three layers: a body, a mantle surrounding its surface and a vacuum in the interior. Measurements in a quasi-monostatic configuration were carried out in a controlled environment: the anechoic chamber of the CCRM in Marseille (Centre Commun de Ressources en Microonde). This configuration allows us to measure the diffracted field over a large portion of the sphere around the object. The imaging methods implemented in this study are based on the observation equation of the diffracted field. This equation allows us to approximate the back-propagated map of the induced current. From a first reconstruction of the inhomogeneous analogue, the external shape as well as the empty core of the object could be visualised and distinguished. This is a promising result for probing the internal structure of asteroids from multi-monostatic radar data.

References:

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