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RADAR PACKAGE FAR A DIRECT OBSERVATION THE ASTEROID'S STRUCTURE FROM DEEP INTERIOR TO REGOLITH

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ABSTRACT

Despite some highly successful space missions to NEO´s, their internal structure remains largely unknown: there is some evidence that an aggregate structure covered by regolith is very common for medium size bodies, but there is no direct observation. The size distribution of the constitutive block is unknown: is it fine dust, sand, pebbles or larger blocks? The observed spatial variability of the regolith is not fully explained and the mechanical behavior of granular materials in a low gravity environment remains difficult to model. Direct measurements are needed to answer these questions, which are of main interest for planetary defense. So modeling of regolith structure and its mechanical reaction is crucial for any interaction of a spacecraft with a NEO and especially for a deflection mission. Regolith vertical structure is needed to model thermal behavior and thus Yarkowsky and YORP accelerations. Determination of the global structure is a way to test stability conditions and evolution scenarios.

To answer these open questions, a radar package has been embedded in the payload of the AIM mission (ESA). In the frame of the AIDA demonstration mission, DART[1], a kinetic impactor is designed to impact the moon of the binary system, 65803 Didymos, while AIM[2] is designed to determine the momentum transfer efficiency of the kinetic impact and to deeply observe the target structure and dynamic state. MASCOT2[3], a small lander, has been developed to be deployed on Didymos' moon.

The monostatic radar on board the spacecraft is high frequency synthetic aperture radar to perform reflection tomography of the first tens meters of the regolith with a metric resolution. It will image the shallow subsurface layering and reconnect the surface measurements to the internal structure. The tomography of the DART crater will provide a better estimate of the ejected mass to model the momentum transfer efficiency. This instrument is a step frequency radar operating from 300 MHz to 800 MHz, derived from the WISDOM radar on board the rover of the ExoMars (ESA-Roskosmos) and optimized to study small bodies.

The bistatic radar is lower frequency radar measuring the wave propagation between the MASCOT2lander and the orbiter throughout the Didymos' moon. It will provide the deep structure of the moon, a measure needed to be able to model the binary formation and stability condition. As beacon on the moon, it will support the determination of the binary system dynamical state and its evolution induced by the impact. This coded radar is an in-time transponder at 60 MHz inheriting from CONSERT on board ROSETTA (ESA).

This radar package and the MASCOT2lander have been developed at phase AB level in the frame of AIM. Despite the fact that AIM funding has not been fully confirmed by ESA Member States during the Ministerial council meeting in 2016, this

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is an instrument package with a large maturity and of main interest for planetary defense as well as for NEO science.

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