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Small Bodies Missions and Technologies (Part 2) (4B)

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DROID: INVESTIGATING 99942 APOPHIS OVER ITS 2029 APPROACH

Abstract

In 2029, on April 13th, the asteroid (99942) Apophis will approach Earth at a distance of 31 000 km. This will be a once-in-millennium opportunity to achieve breakthrough science and strengthen planetary defense capabilities by addressing two primary goals: - Find out if, and how much, such a close planetary encounter causes changes in some of the physical and dynamical properties (e.g., interior, surface, spin properties) of an asteroid. - Understand the interior structure of a small and likely rubble pile asteroid and draw implications for its formation, evolution and response to a deflection attempt;

To meet these two objectives, a mission concept has been developed in a collaboration between NASA/JPL and CNES. The Distributed Radar Observations of Interior Distributions (DROID) mission plans to rendez-vous with Apophis in late Summer 2028, seven months prior to Earth closest approach

(ECA), and escort it through the encounter. DROID's measurements will determine the interior structure and properties, the body's shape, morphology and spin properties as well as observe any resolvable changes during the Earth encounter. The proposed mission architecture is based on three spacecraft: a mothership with high delta-V capabilities, led by JPL, and two CubeSats equipped with inter-satellite link and bi-static radar technologies to be developed by CNES and the University of Grenoble.

The three spacecraft will launch on a dedicated launcher procured by JPL. During the mission, DROID's mothership, will carry the CubeSats to Apophis, achieving cruise trajectory and the orbital insertion around Apophis, and will relay to Earth all the data acquired through the mission. It will characterize Apophis' physical parameters, and provide critical pre-ECA high resolution imagery in order to detect any change that may affect Apophis' surface.

After being deployed from the mothership, the two CubeSats will insert themselves into coordinated low orbits to perform monostatic and bistatic radar observations. Inter-Spacecraft Link (ISL) S-band transponders installed on all three spacecraft will allow for data transfer, and will synchronize the CubeSat clocks for accurate bi-static radar measurements. This will also enable an accurate knowledge of the CubeSats' orbits to support radio science investigations. Indeed, it will allow for retrieving first-order gravity field values related to the larger scales of the interior heterogeneity.

This IAC talk will elaborate on the unique opportunity of this mission, its objectives and its global architecture, and will highlight the CubeSats design and their bistatic radar and associated ISLs.