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Small Bodies Missions and Technologies (Part 1) (4A)

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THE ESA RAMSES MISSION CONCEPT: A RENDEZVOUS WITH THE ASTEROID APOPHIS DURING ITS CLOSE ENCOUNTER WITH EARTH IN 2029.

Abstract

(99942) Apophis is a potentially hazardous asteroid with a 340-meter diameter that on April 13, 2029 will approach Earth's surface at a closer distance than orbiting geosynchronous satellites. Significant tidal torques will be exerted on Apophis, with consequences that might include alterations of its rotation state and internal structure, measurable seismic waves and real-time surface disturbances.

This very close Earth flyby presents an unprecedented planetary defense and science opportunity. A rendezvous mission could allow transforming our understanding of the response of small asteroids to external forces and of the internal structure of potentially hazardous asteroids. A small-satellite ESA study ("RAMSES", Rapid Apophis Mission for SEcurity and Safety) is exploring an adaptation of the Hera spacecraft design, to fit to the updated mission profile, while minimizing any new developments given the short timescale until launch. To rendezvous with the asteroid before April 2029, RAMSES needs to launch in April 2028 for a direct 10-months transfer.

RAMSES will rendezvous with Apophis two months before its Earth closest encounter on April 13, 2029 and will perform a detailed characterization campaign (including global imaging at 10cm resolution), both before and after this close encounter, in great synergy with NASA's OSIRIS-APEX that will visit Apophis in the following few days, emphasizing the international cooperation that is at the heart of planetary defense. During the close encounter, Apophis will be characterize with high temporal resolution to observe in detail the above mentioned alterations. RAMSES will embark as a minimum two visible cameras and two 6U-XL CubeSats to be released in proximity of Apophis before the close encounter and will operate independently, using RAMSES as relay satellite. One of the two CubeSats may land on Apophis before the close encounter, carrying instruments such as seismometers or gravimeters. Additional payloads will be accommodated either on RAMSES or on the CubeSats on the basis of available on-board resources. These might include a Thermal Infrared Imager, a Low Frequency Radar, Dust Detectors, a Laser Altimeter, and/or other possible instruments of interest for planetary defense and science purposes.

The RAMSES study aims at defining a mission architecture and spacecraft design based on maximum reuse of existing equipment and proven system/subsystem architectures. The studies will be instrumental to make an informed decision at ESA's CM25 as part of the planetary defense roadmap, both on the most effective technical solution as well as implementation approach to reduce mission costs and allow fast implementation.