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

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RAMSES – ESA'S STUDY FOR A SMALL MISSION TO APOPHIS

Abstract

99942 Apophis is a potentially hazardous asteroid with a diameter of about 370 meters that on April 13, 2029 will approach Earth's surface at distance that is closer than geosynchronous satellites. Tidal torques will be exerted on Apophis, with consequences that might include alterations of its rotation state, internal structural, measurable seismic waves and real-time surface disturbances.

This very close Earth flyby presents an unprecedented planetary defense and science opportunity. A mission to Apophis could allow transforming our understanding of the geophysical evolution of potentially dangerous asteroids. As such, several parallel studies of small missions to Apophis have been launched by ESA.

The first is "Satis", a study within the ESA S2P Programme based on a 12U CubeSat; in parallel a small-satellite study ("RAMSES", Rapid Apophis Mission for SEcurity and Safety) is exploring two implementation approaches: an adaptation of the Hera spacecraft design, and an open concept small-satellite mission.

To rendezvous with the asteroid before April 2029, RAMSES needs to launch in April 2027 followed by an Earth flyby in April 2028 or launch for a direct 11-months transfer in April 2028 if 1530 m/s deltaV can be accommodated.

RAMSES will rendezvous with Apophis two months before its Earth's close encounter and will perform a detailed characterization campaign of the asteroid (including global imaging at 10 cm resolution), both before and after the close encounter on April 13th, 2029. In addition, during the close encounter, characterization of Apophis with high temporal resolution will be performed to observe in detail the above mentioned physical and dynamical alterations.

RAMSES will embark as a minimum two visible cameras (possibly based on Hera's AFCs) and two 6U-XL CubeSats to be released in Apophis proximity before the close encounter. They will operate independently, using RAMSES as relay satellite. Additional payloads will be accommodated either on RAMSES or on the CubeSats based on available on-board resources. These might include a Thermal Infrared Imager, a Laser Altimeter, a Low-Frequency Radar, Dust Detectors, Seismometers, Penetrators, Microscopes, Radiometers, Laser Retro Reflectors and others.

The RAMSES studies aim at defining a mission architecture and spacecraft design based on maximum reuse of existing equipment and proven system/subsystem architectures ("heritage building blocks").

The studies will be instrumental to make an informed decision at ESA's CM25 as part of the S2P/planetary defense roadmap, both on the most effective technical solution as well as implementation approach to reduce mission costs and allow fast implementation.