Multiple CubeSats Provide Close Apophis Imagery During Earth Passage

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Introduction:

By being in place before, during and after the Apophis fly-by, the mission will deliver science value to NASA that enhances OSIRIS-APEX, that arrives one week after Earth fly-by Figure (1). The mission will address goals defined in the National Preparedness Strategy & Action Plan for Near-Earth Object (NEO) Hazards and Planetary Defense executive report [1].

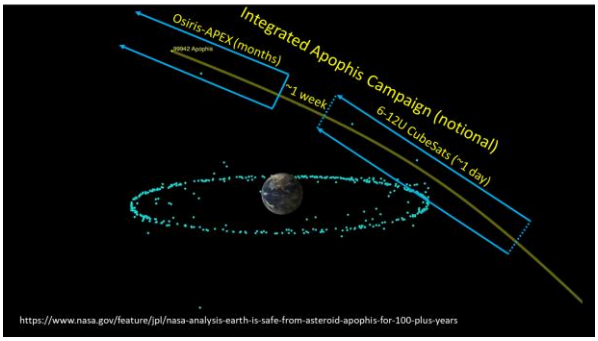

Figure 1. CubeSat Apophis Complements NASA's OSIRIS-APEX Mission

Operational View:

Apophis-CubeSat operational view (Figures 2 and 3) consists of 20 6-12U cubesats launched to a "waiting room" by dedicated launch or rideshare 6–12 months prior to Apophis passage. They fly in holding orbit until time to move onto Apophis intercept trajectories ("go to stations"), and sequentially view Apophis from multiple "stations" with standoff distances as close as 5 km.

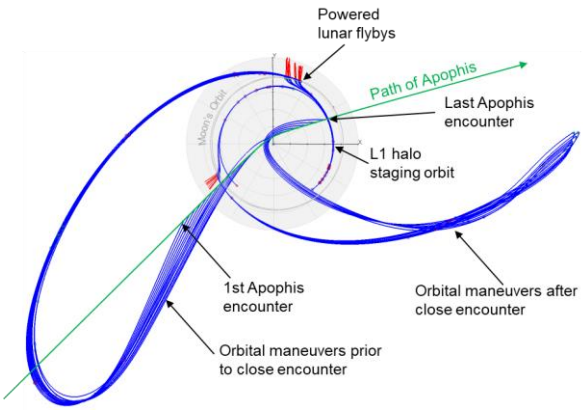

Figure 2. Apophis-CubeSat Large Scale operational view

This Apophis fly-by and post fly-by mission ops in Cislunar space will create a foundation for CONOPS and C2 to enable future cislunar missions.

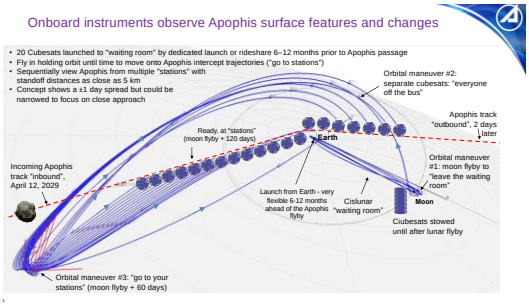

Figure 3. Apophis-CubeSat closeup operational view

The above figures show how the 20 instrumented cubesats make sequential observations as Apophis transits the Earth's gravitational field. This is the portion of the Apophis flight in which tidal forces can create changes in the shape, rotational rate, spin axis and surface characteristics to be observed by this series of measurements. During the ~30 hour passage, the fleet of cubesats will be stationed to observe Apophis at one hour intervals - as the asteroid flies from 1,000 km to within 5 km of each cubesat – creating a virtual "video" of the surface variations.

Development Activities:

In 2023, we developed the mission concept and refined it to a compelling launch-and-dwell mission; we have established collaboration with AFRL, NASA and the USSF; we received feedback on our mission concept from NASA PDCO and adjusted accordingly; we have worked with KinetX for modelling our concept as it relates to the NASA OSIRIS-APEX program; we are evaluating a TRL-9 imaging payload that the Aerospace Concept Development Center is assessing integration into a generic 6-12U cubesat-class spacecraft; we have partnered with NSIN/SSC for a university Capstone Project with UCLA, USC, CalTech and UT Austin. In 2024 we further develop the concept design and mission, and define technology and science objectives to engage the customer and science community. In 2025, the objective is to develop the program structure, perform design tasks, modeling and simulation, and identify and resolve risks.

References:

[1] “National Preparedness Strategy & Action Plan for Near-Earth Object Hazards and Planetary Defense,” Planetary Defense Interagency Working Group, April 2023, https://www.whitehouse.gov/wp-content/uploads/2023/04/2023-NSTC-National-Preparedness-Strategy-and-Action-Plan-for-Near-Earth-Object-Hazards-and-Planetary-Defense.pdf?trk=public_post_comment-text