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OSIRIS-APEX: IMPLICATIONS OF MISSION OBJECTIVES FOR PLANETARY DEFENSE

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ABSTRACT

The OSIRIS-APEX (Origins, Spectral Interpretation, Resource Identification, and Security–Apophis Explorer) mission will rendezvous with the 340-m-diameter asteroid (99942) Apophis after its close approach to Earth on April 13, 2029. The tidal forces experienced during the encounter are expected to alter the orbit and spin state of Apophis, as well as cause potential surface changes (e.g., Dotson et al., 2022 and references therein). The APEX spacecraft, which was designed to study the asteroid Bennu at very high spatial resolution, will take this opportunity to investigate in detail the evolution of Apophis after close approach. Beyond revealing the impact of tidal interactions on an asteroid, the mission will provide centimeter-scale global morphology,

meter-scale maps across a broad range of wavelengths (0.4–100 microns), and constraints on mass, interior structure, and surface properties. Because Apophis represents the most common taxonomic class of potentially hazardous asteroids, the Sq-complex (e.g., Binzel et al., 2019), obtaining geotechnical measurements is one of the mission goals.

Impact mitigation strategies for hazardous asteroids depend on a priori assumptions applied to a diverse set of objects. The close reconnaissance of Apophis is an excellent opportunity to test those assumptions and acquire measurements that can only be made by rendezvous missions. By evaluating the gravity field and shape of Apophis, APEX will reveal whether Apophis is mechanically a monolith, composed of large fragments, or a rubble pile. By performing a maneuver wherein the spacecraft approaches Apophis then backs away to excavate subsurface material with its thrusters, APEX will provide new insight into the near-surface geotechnical properties. By monitoring the spacecraft's position as it orbits Apophis, APEX will directly measure the post-Earth encounter Yarkovsky acceleration. This, paired with detailed mapping of the surface thermal properties, will elucidate the Yarkovsky effect in unprecedented detail.

Additionally, the rare close encounter of Apophis with Earth will provide excellent viewing conditions for many ground-based observatories, and the APEX mission will provide important "space-truthing" for such observations. Comparing in situ rendezvous data from APEX with ground-based observations will enable: (1) synergistic analysis and calibration of all datasets and (2) improved higher-order science products. In particular, data returned by APEX will help to assess the accuracy of ground-based measurements and understand the extent to which they can reliably reduce uncertainties in properties relevant to planetary defense. Such coordination will advance our ability to use ground-based observations to inform both asteroid science and planetary defense. Thus, the Apophis close encounter and APEX mission present the opportunity for a globally coordinated planetary defense exercise using both ground- and space-based assets (Barbee et al., 2021).

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Binzel, R. P. et al. (2019) Icarus, doi: 10.1016/j.icarus.2018.12.035.
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