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**EXPLORING ROTATIONAL, SURFACE AND INTERIOR CHANGES OF THE
NEA/PHA APOPHIS DURING ITS 2029 CLOSE ENCOUNTER WITH THE EARTH**

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ABSTRACT

In April 2029, the asteroid (99942) Apophis will pass within ~36,700 km (5.7 Earth radii) of the Earth, and has the potential to impact our planet during a distant future encounter. The close proximity of Apophis' Earth flyby provides a rare opportunity to investigate and monitor a full range of geological and dynamical processes that are known to influence the rotation state, exterior, and interior of most NEAs over the course of a planetary tidal encounter, and offers an opportunity to measure its interior structure. Apophis is an excellent target because it is well observed, and representative geologically, chemically and dynamically of S-type NEAs. A detailed survey such as that proposed in the Apophis Probe Experiment (APEX, a mission study examined for NASA's Small Satellite and Discovery programs) would enable science investigations that are critical to our understanding of the physical nature of this and other NEAs, and our ability to prevent future collisions.

Several APEX mission goals pertain to planetary defense: (1) observe and model Apophis' rotational state before, during, and after the 2029 Earth encounter to understand how shape, interior, and starting rotational state influence the asteroid's subsequent dynamical behavior; (2) observe and model regolith spectral and morphological properties to determine whether and why changes occurred as a consequence of the tidal encounter with the Earth; and (3) explore the interior structure and the effects of natural seismic sources (micrometeorite impacts and tides) and artificial active ones. The APEX mission, in this context, would be unlike any other small body mission, because in addition to measuring the interior structure of Apophis, it also observes key geological processes as they happen.

To achieve these and other mission goals, the payload would include narrow- and wide-angle imaging systems, a thermal imager, a laser altimeter, seismometers, and seismic sources. Rendezvous mission operations include mapping the entire surface before and after the Earth encounter, emplacement of seismometers, monitoring of seismic activity, and conducting an active seismic experiment (deployment and detonation of seismic sources). During encounter with Earth, APEX would observe Apophis to monitor changes in rotational parameters (polar orientation and period).
