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ATENA: A SMALLSAT MISSION FOR THE 2029 APOPHIS RENDEZVOUS

Abstract

The impending close flyby of Earth by the Apophis asteroid in April 2029 presents a unique opportunity for scientific exploration and planetary defense. The ATENA (Advanced Technology Exploration of NEA Apophis) mission fosters an international collaboration between the Italian Space Agency (ASI) leading the mission, NASA/GSFC (Goddard Space Flight Centre) who will lead the flight dynamics activities and the provisioning of the BIRCHES payload, managing the support of the Deep Space Network as well, and ARGOTEC, responsible for the platform development, integration, and operations. ATENA aims to characterize Apophis and demonstrate SmallSat-enabled rapid-response capabilities for potentially hazardous Near-Earth Objects (NEOs). The mission will be based on a microsatellite platform which, upon separation from the launch vehicle, will embark an interplanetary transfer using its electric

propulsion system, finalizing the transfer with the Apophis rendezvous at around 0.45 AU from Earth. Proximity operations will take place through hyperbolic arcs around the asteroid at distances as close as a few kilometers, following the asteroid up until its Earth closest approach and beyond. To be considered successful, the mission will have to recover, for both pre- and post-encounter conditions, Apophis' shape model, rotation state, gravity, albedo, color imaging, crater map, boulder map, and spectra. Navigation poses a challenge due to uncertainties in the asteroid's shape and rotation state. Options include classical radiometric measurements and optical navigation, with the latter requiring a robust telecommunication subsystem, thus forcing to have a High Gain Reflectarray Antenna on board. The payload suite comprises optical and spectral instruments, including wide-field and narrow-field cameras (LUKE and LEIA) from ARGOTEC's LICIACube, alongside the BIRCHES infrared spectrometer developed by NASA/GSFC. These instruments enable comprehensive observations of Apophis' surface features and volatile-related characteristics in the spectral region from 0.4 to 4.2 μm. The spacecraft architecture, based on ARGOTEC's Hawk Platform, features deployable and steerable solar wings, electric propulsion, and the UST-Lite X-band transponder. In conclusion, as the natural continuation of ARGOTEC's LICIACube mission, ATENA represents a pioneering effort in asteroid exploration and planetary defense, leveraging international collaboration and cutting-edge technology to enhance the comprehension of NEOs like Apophis while demonstrating rapid-response capabilities for future NEO threats.