

SET: Picosatellite Mission to Study Apophis

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Apophis is an asteroid in a near-Earth orbit. It is approximately 375 meters in diameter. Its close approaches to Earth in 2029 and 2036 make this asteroid of particular interest to researchers. Very little is known about Apophis apart from some grainy radar images. Soft-landing a large spacecraft on an asteroid or comet of less than 5 km is expensive and complex because significant ΔV needs to be imparted to slow the vehicle down, anchor it, and keep it stationary as shown by the recent Philae lander on the Rosetta mission. It is significantly easier to deploy one or more low-mass spacecraft onto an asteroid to perform surface exploration. The SET project of Arizona State University proposes sending a 1 kg, 1000 cm³ picosatellite aboard an orbiter to collect geophysical data on the asteroid's surface and internal compositions. SET would be equipped with a combination of cold-gas thrusters and reaction wheels to allow mobility. SET would gather three types of data. First, an imaging system would take photos of the surface from various altitudes to show Apophis' gross and fine configurations. Images are expected to be 1024 x 768 pixels, with resolution on the order of 0.2 mm per pixel for those captured at the surface. Second, a penetrometer would be employed at several sites to better understand surface conditions. The penetrometer unit will make use of a combination of strain gauge, piezoelectric force sensor, and a thermocouple to measure grain size, to determine layering of materials, and to measure temperature gradients. The instrument will be deployed by telescoping down into the surface of Apophis, allowing a measurement depth greater than the 10 cm height of the satellite. Third, three seismographs would be emplaced on the surface before triggering a percussive charge. It will be possible to analyze the resulting P- and S-type seismic waves to gain greater insight into Apophis' internal structure and density. Similar systems have been used both on Earth and on other planetoids in previous missions. The small relative size of Apophis allows SET to use a very small charge to accomplish its goals. Work is progressing on developing a fully working prototype for mid-2015, culminating in an orbital or sub-orbital experimental flight shortly thereafter.