

SMALL SATELLITE MISSIONS SYMPOSIUM (B4)  
Small Space Science Missions (2)

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APOPHIS 2029, A UNIQUE MISSION OPPORTUNITY

**Abstract**

APOPHIS, which has been discovered in 2004, is a 250 meter wide asteroid that will come back very close to the Earth on April 13, 2029.

In the same manner a gravity assist maneuver is currently used for a deep space probe, the gravitational pull of the Earth during its pass will dramatically modify APOPHIS orbit around the Sun. The equivalent  $\Delta V$  that will be provided by the Earth during this flyby is about 2.8 km/s. From period of 323 days prior to the flyby, the orbital period of APOPHIS around the Sun will be increased by about one hundred days.

The present uncertainty on the perigee altitude of APOPHIS swing-by is about 3,000 km, which corresponds to a ten day span, between 417 and 427 days, for the subsequent period. If this new period is exactly in resonance with the Earth's 365.25 day period, APOPHIS can impact the Earth in 2036, 2037 or later in the future.

During its 2029 pass, APOPHIS will be easily visible from the Earth and it can be expected that its geometry and thermal properties will be well determined from ground based observations. However, the characterization of its interior will not be achievable from purely terrestrial observations. Such a characterization is essential for planning any mitigation operation, should it be necessary in the future.

This can only be done through a dedicated space mission where a set of instruments for probing its interior will be softly laid down on its surface.

The main features of the April 2029 APOPHIS pass will be a hyperbolic trajectory, in a plane inclined by 40 degrees over the Earth equator and a perigee altitude lower than 40,000 km. Its hyperbolic excess velocity will be 5.86 km/s and the velocity at perigee 7.4 km/s. It will only spend 2 hours at an altitude less than 40,000 km from the Earth surface. This short duration is an important constraint for accomplishing a space mission aimed at probing the interior of APOPHIS.

Unlike previous deep space missions dedicated to the study of asteroids, the mission that is presented here can be considered as a low cost one for two reasons:

- it is a short duration mission: there will only be a few weeks between the launch and the end of the flyby operations
- the distance to the Earth will remain under 60,000 km so the requirements for launch and telemetry will be less stringent than for a deep space mission.

The paper will present the objectives of the mission, its preliminary design and compare it to other types of mission.