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A cubesat mission to asteroid Apophis based on M-ARGO?

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ABSTRACT

Asteroid Apophis will have a very close approach to the Earth on 13 April 2029. The flyby will multiply the orbit uncertainties of the object, and an impact in one of the later flybys can currently not be excluded. Due to its close Earth flyby, a detailed physical characterization using ground-based techniques will be possible. An even better characterization would be achieved via an orbiting mission. ESA has studied a mission concept (called M-ARGO) based on CubeSat technology that could be used to characterize an asteroid. In this paper, we apply this study to asteroid Apophis.

Even though Apophis gets close to the Earth, this does not mean that it can be easily reached by a space mission. Our mission analysis results show that with a typical delta-v cost of around 5 km/s, transfers are comparable to Mars or Venus missions. A scenario for a low-cost launch might be as co-passenger into GTO or even LEO, using a kick stage for Earth escape. One possible mission would launch in April 2028

and arrive at the asteroid in February 2029, 2 months before the close encounter with the Earth (see Figure 1).

M-ARGO would be a 12-unit CubeSat with a dry mass of about 20 kg, plus about 2 kg of fuel. It incorporates electric propulsion for maneuvers, and a three-axis stabilized attitude control including Sun sensors and a star tracker. It would have a deployable reflect-array high-gain antenna and four low-gain antennae. A body-mounted and two deployable solar arrays would generate between 90 and 120 W of power at 1 au solar distance. The payload would consist of a VIS to SWIR (500 nm to 2500 nm) spectral imaging system to determine the surface composition of Apophis, a high-resolution visible range camera for topography and regolith measurements, and a laser rangefinder, which, combined with an ultra-stable oscillator, would enable radio science for gravity field measurements.

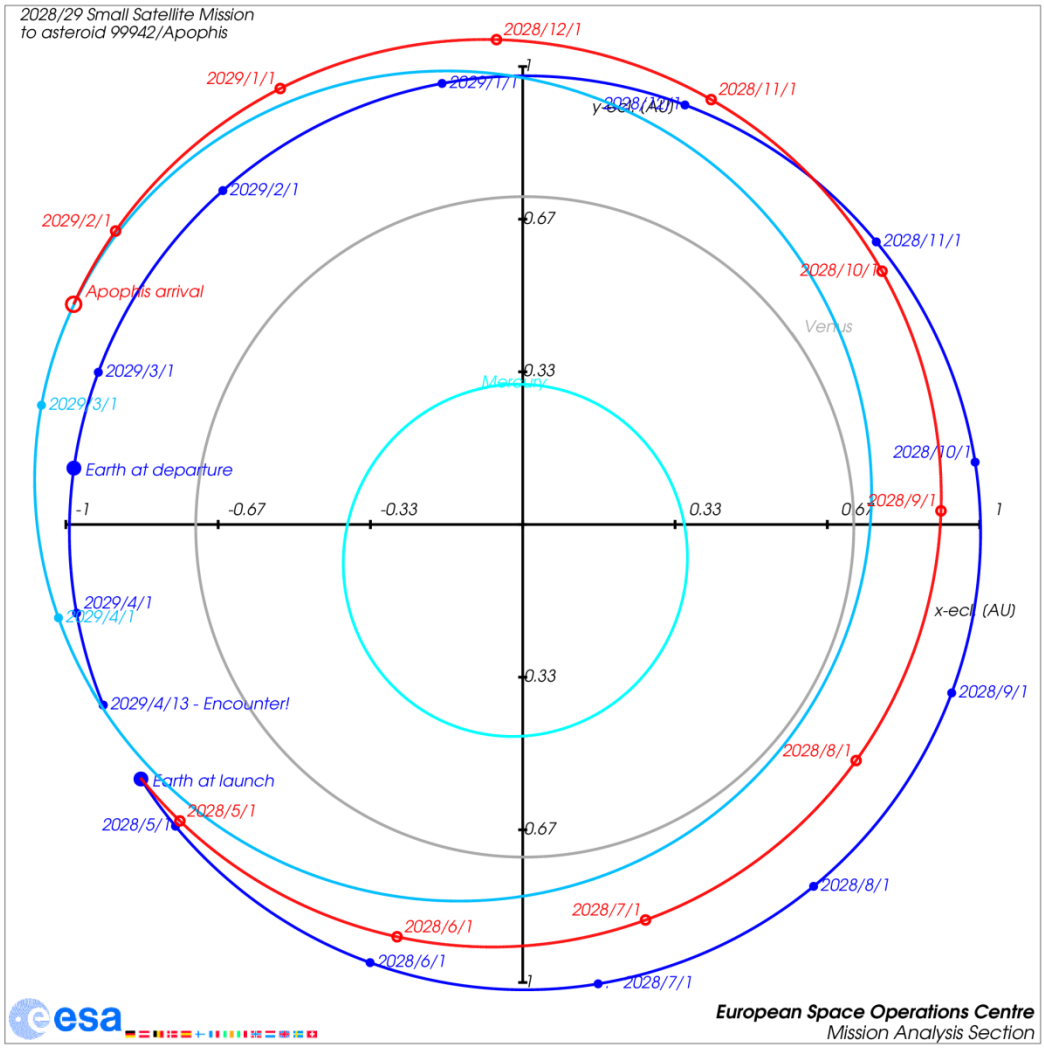

Figure 1 – Possible trajectory for a mission to Apophis

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