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X Ongoing and Upcoming Mission Highlights
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☐ Near-Earth Object (NEO) Discovery
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French involvement in Planetary Defense Missions

P. Bousquet[1], P. Annat[1], R. Garcia[2], Ph. Guillemot[1], A. Herique[3], P. Michel[4], A. Moussi-Soffys[1], N. Murdoch[2], V. Piou[1]

[1] *Centre National d'Etudes Spatiales, Toulouse, France*
pierre.bousquet@cnes.fr, +33 5 61 28 17 18
[2] *Institut Supérieur de l'Aéronautique et de l'Espace, Toulouse, France*
[3] *Université Grenoble Alpes, CNRS, CNES, IPAG, 38000 Grenoble, France*
[4] *Université Côte d'Azur, Observatoire de la Côte d'Azur, CNRS, Laboratoire Lagrange, Nice, France,*

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CNES contributes to the most essential Planetary Missions of this decade, aimed to the binary asteroid (65803) Didymos, and to the asteroid (99942) Apophis. We start with the Hera mission launched by ESA on October 7th 2024. Its target, Dimorphos, the 151 meters moon of Didymos, was successfully impacted by NASA's DART proe on September 26th 2022. Hera now aims to observe the effects of this impact in situ and study the binary asteroid's geophysical characteristics.

Hera combines a mother-spacecraft, with five instruments, and two Cubesats, Juventas and Milani. Hera will conduct the first ever radar survey of an asteroid's interior with the JuRa mono-static radar on Juventas, which has a French Principal Investigator from IPAG. The mothership will be controlled from ESOC in Darmstadt, Germany, and the two cubesats from ESEC in Redu, Belgium. CNES, in Toulouse, is

in charge of proximity operations for the cubesats, including trajectory control and instrument planning, from their separation from Hera to asteroid landings.

Apophis is also an exceptional target on the occasion of its Earth approach at a distance of 31 000 km on April 13th 2029. This will be a once-in-millennium opportunity to address two primary goals:

- Find out how much such a close planetary encounter causes changes in some of the physical and dynamical properties of an asteroid,
- Understand the interior structure of a small and likely rubble pile asteroid and draw implications for its formation, evolution and response to a deflection attempt.

CNES has been working since 2022 with JPL on the Caltech mission to characterize Apophis (to be presented by Carol Raymond from JPL at this PDC), based on three spacecraft: a mother-ship, and two CubeSats equipped with a bi-static radar derived from JuRa mentioned above. At this stage, CNES is considering to contribute to the radar, and to provide the ISL S-band equipment installed on all three spacecraft which will synchronize the CubeSat clocks through a loop with the mothership to achieve accurate bi-static radar measurements.

ESA has also initiated the development of RAMSES, that will launch towards the end of April 2028 and reach Apophis two months before its Earth's close encounter. RAMSES benefits from a strong HERA heritage and is based on the same architecture, with a mothership and two cubesats. It will characterize Apophis with high-resolution before and after the encounter. CNES is considering to participate to RAMSES' cubesat operations, and to the investigation of Apophis internal structure with a contribution to a monostatic tomography radar similar to JuRa, with a seismometer based on geophone technology to be provided by ISAE, and possibly with a near infra-red camera. In addition, CNES is studying a fly-by probe equipped with visible cameras that would share RAMSES' launcher. This would be a very valuable Planetary Defense demonstration where a potentially threatening asteroid would be observed through a fly-by, and those results could be confronted a few weeks later to the extensive characterization obtained by Caltech mission to Apophis, RAMSES, and Osiris-Apex.

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Comments: Oral