PDC2021
Vienna, Austria

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BIRDY - NANOSATELLITES FOR RAPID RECONNAISSANCE MISSION

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Keywords: *PHA, reconnaissance mission, nano-satellites, inter-satellites link, characterisation.*

ABSTRACT

Should an asteroid, or other celestial small body, be on high risk of impacting with the Earth, a reconnaissance mission has to be sent to characterise the object and assess the risks [e.g. Harris et al. 2013 NEOshield, SMPAG, Barbee et al. 2020 NNPSAP]. While ground-based remote observations are essential to track the object-–as long it is visible—and monitor its impact probability (IP) evolution, only close-range *in-situ* observations from space in a *rendez-vous* mode or otherwise as *fly-by* can reveal the most important and basic parameters needed to assess the risk and prepare for planetary defence actions. A reconnaissance or precursor mission, should bring the basic yet fundamental information of the target's shape and size, binarity, mass and porosity, and accurate orbit to localise the impacting path on Earth. These are needed to fully assess the risks (impact probability, location path on Earth, and potential damages), and to design mitigation measures, accordingly. Such reconnaissance mission is particularly relevant for a potentially hazardous asteroid (PHA) in the size range of a few 10s to several 100s meters large. Given potential short alert time, a reconnaissance mission has to be developed very rapidly, and needs to reach the PHA at earliest time possible. As stated in one of US "National Near-Earth Object Preparedness Strategy and Action Plan" goals, and

adopted by the international UNOOSA/SMPAG group, one of the strategic objectives is to develop technologies and designs for rapid-response NEO reconnaissance missions. SmallSats and nanosatellites offer clear advantages for such reconnaissance purposes, in the case of a mitigation mission to be performed in short warning time, in the particular context of little mission-planning margins.

Here we propose—within our BIRDY project—to develop the concept of a space mission with nanosatellites to ensure such reconnaissance mission. We are analysing at Paris observatory, within the CENSUS PSL university centre https://cceres.psl.eu, the global feasibility and performances reachable by relative measurements through inter-satellites link (ISL), assessing the capabilities offered by use of current technologies. Key to the concept is to design a mission that can provide the basic asteroid's parameters with a simple payload and design, with very few instruments, and that could moreover be acquired or manufactured rapidly without additional design development. Increasing the mission's autonomy and reducing its complexity, possibly making use of COTS or well-tested and standard components already available on the market, is one of the driving factor. Another key figure is to make use of relative measurements to characterise the PHA's physical & dynamical properties. So, the mission consists of small nanosatellites and a carrier satellite, with imaging capabilities and intersatellite link (radio or optical). The carrier satellite provides the propulsion for reaching the target, the deployment of the nanoprobes, the antenna and transponder for the radio-science and data transmission to the ground segment. The nanosatellites ensure short-range inter-satellite communication capabilities to monitor their relative trajectories similarly to Walker et al. 2019 LCPM. Such mission is adapted to the less favourable case scenario of a single flyby by a swarm of nanosatellites, but can as well provide more information, would a rendez-vous mission lasting several months be possible. We will show the present status of our developments and general concept validation.

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[2] Barbee, B. et al. 2020. Future Spacecraft Missions for Planetary Defense Preparation. *White paper submitted to The Planetary Science and Astrobiology Decadal Survey*, 2023-2032.
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Comments:

(Poster – alternate session NEO Characterization Results)