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**MASCOT ASTEROID NANOLANDERS: FROM RYUGU AND DIDYMOON
TOWARDS FUTURE MISSIONS AT '2021 PDC', APOPHIS 2029, AND BEYOND**

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ABSTRACT

For now, the Planetary Defense Conference *Exercise* 2021's incoming *fictitious(!)* asteroid, 2021 PDC, seems headed for impact on October 20th, 2021, exactly 6 months after its discovery. Today (April 26th, 2021), the impact probability is 5%, in a steep rise from 1 in 2500 upon discovery six days ago. We all know how these things end. Or do we? Unless somebody wants to keep civil defense very busy very soon, the chance is 95% that it will not hit; instead fly by closely to Earth, swing by to a new orbit that takes it away essentially forever or back again sooner or later through a keyhole, for a re-play at different odds. This is where our story starts and the story sounds familiar: season's greetings from 2004 MN₄, now better known as (99942) Apophis. One more thing is similar: the close fly-by is an easy launch opportunity to 'jump aboard' that potentially hazardous asteroid for planetary science and tracking of longterm Yarkovsky-shifted keyhole resonant return risks. Indeed, missions are currently being discussed to launch during the 2029 fly-by of Apophis to rendezvous and investigate it closely right after. Others strive for an earlier launch to rendezvous well before, to observe all of the close fly-by at Earth and what it might do to a likely delicate rubble pile asteroid. Presently, this is an unlikely if not impossible option for sudden encounters like 2021 PDC with a lead time of months. But *when* asteroid mining (...possibly the other ...-not-if of asteroids?) takes off in the same manner as low Earth orbit communications satellites, this option may become a reality. But for now, even if a suitable planetary mission were serendipitously ready atop a suitable launch vehicle, could you get it an asteroid lander within 6 months? Surprisingly, this option existed between late 2014 and late 2018 when the MASCOT Qualification Model turned Flight Spare was kept fully integrated and flight ready for on-ground testing to prepare for the Flight Model's brief but complete mission on Ryugu with JAXA's highly successful HAYABUSA2 probe. At the same time, the MASCOT2 detailed design study for ESA's former AIM mission within the common NASA-ESA AIDA mission to (65803) Didymos and its moonlet, Dimorphos (then affectionately known as 'Didymoon'), paved the way for long-life MASCOTs, many of which have been discussed and studied since. The thoughtful design of MASCOT's hardware and software allowed for a very high degree of re-use and flexibility regarding scientific payloads. MASCOT2 was to investigate the interior of Didymoon by Low-Frequency Radar. Close encounters like Apophis' offer unique opportunities for Earth-based planetary radar assets to work with spacecraft near and landers on the passing asteroid. We present a range of options for radar- and composition-oriented long-life MASCOT variants – to be delivered to the surfaces of the respective asteroid bodies – for the presently most likely near miss of 2021 PDC and the most certain close fly-by of (99942) Apophis on Friday, April 13th, 2029.

Comments: oral presentation preferred, poster (or equivalent) welcome

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