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Flyby Asteroid Reconnaissance (FLARE) mission to Apophis: A mission concept to Apophis before its Earth encounter to demonstrate flyby reconnaissance for planetary defense

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ABSTRACT

We present a concept called the Flyby Asteroid Reconnaissance (FLARE) mission that would use the (99942) Apophis close approach in 2029 to demonstrate a flyby reconnaissance mission for planetary defense (PD). FLARE targets a launch date that would allow for an Apophis flyby before its April 2029 Earth encounter, allowing us to observe the surface conditions on Apophis prior to its Earth encounter.

Why PD flyby? The more that is known about an asteroid threat, the better we can plan an effective mitigation response. A spacecraft reconnaissance mission would retire key knowledge gaps, if time allows. Depending on the timeline and orbital mechanics, a flyby mission might be the only viable option for spacecraft reconnaissance. For these reasons, rapid flyby reconnaissance has strong support in the PD community [1,2], and was recommended by the decadal survey as the third U.S. PD mission [3].

Why Apophis? Apophis presents two unique opportunities to address strategic knowledge gaps for PD: i) Apophis will be the smallest asteroid to be rendezvoused by a U.S. mission when OSIRIS-APEX visits it in 2029 [4] and ii) the close approach will trigger physical changes on Apophis due to tidal forces [5]. Data collected by APEX's New-Frontiers-class instruments will enable the validation of measurements obtained by a flyby mission and changes triggered by the tidal encounter will provide insight into the surface and interior properties of the most common type of potentially hazardous asteroids (PHAs).

Why now? Similar to a real asteroid threat scenario, Apophis 2029 represents a date with fate. In both cases, the asteroid chooses the date and sets the timeline for the world's response. Only Apophis reconnaissance that occurs before its Earth encounter will provide a "before-picture" that would provide a more complete understanding of the influence of close encounters on PHAs [5].

The goals of FLARE include: 1) measure asteroid properties relevant to PD, 2) compare flyby-derived quantities to OSIRIS-APEx and ground-based observations, and 3) provide high-resolution color imaging of the surface before the Earth encounter.

To achieve these goals, FLARE will carry the Flare Imager (FLI) and the Flyby Asteroid Mass Experiment (FLAME). FLI is a rebuild of DART's DRACO imager [6] that would be updated with an RGB color detector to allow high-resolution color mapping. FLAME consists of a deployable CubeSat with an X-band transponder that will provide a mass measurement through Doppler-Gravimetry.

The FLARE mission provides valuable information about Apophis prior to its close approach and data to assess the utility of a flyby for PD via comparisons with data from OSIRIS-APEX.

References:

1. National Near-Earth Object Preparedness Strategy and Action Plan (2018)
2. Planetary Defense Interagency Tabletop Exercise 4 After Action Report (2022)
3. Origins, Worlds, and Life. The National Academies Press. (2022)
4. DellaGiustina, D.N. OSIRIS-REx Update for SBAG. SBAG, LPI (2022).
5. Dotson, J. L. et al. Apophis Specific Action Team Report. SBAG, LPI (2022)
6. Fletcher, Z., et al. SPIE Proceedings Vol. 10698 (2018).