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**AOPHIS PATHFINDER: A MILO SPACE SCIENCE INSTITUTE SMALLSAT
MISSION IN SUPPORT OF SCIENCE AND PLANETARY DEFENSE**

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ABSTRACT

The MILO Space Science Institute (<http://miloinstitute.org>), a nonprofit entity led by Arizona State University with support from Lockheed Martin, was formed to provide affordable access to space science missions, especially for new entrants in the realm of deep space robotic science and engineering. MILO's business model is built on the hypothesis that compelling, science-driven deep space missions can be led, organized, and conducted by a consortium of U.S. and international organizations, aided by mentorship and other support from experienced organizations like ASU and Lockheed. As a seed to growing such consortia, MILO has defined an initial set of potential smallsat missions that could be done relatively quickly, at low to modest cost, and that would achieve cutting-edge Decadal quality science. One such mission is called Apophis Pathfinder [1], which will launch a pair of Janus-scale rideshare smallsats to conduct a flyby precursor investigation to characterize the PHA (99942) Apophis well in advance of its April 2029 extremely close approach to Earth.

The MILO Apophis Pathfinder mission will provide initial reconnaissance data to inform and influence planning for additional missions to (99942) Apophis in 2029 and beyond, such as NASA's OSIRIS-REx APEX extended mission. Science and Planetary Defense objectives of the Apophis Pathfinder mission include obtaining more precise estimates of the asteroid's mass and density, shape, geology, composition, and orbital parameters. To achieve these objectives, the smallsats will carry small and high-heritage payloads like miniaturized optical and thermal-IR cameras and a near-IR point spectrometer, and will implement the first deep-space demonstration of a novel method of determining the mass of sub-km size asteroids using multiple deployed and optically and/or radio-tracked small spherical "probesats".

(99942) Apophis will make a number of relatively close approaches to Earth before its famous 2029 extremely close encounter, with the closest of these being two approaches at < 0.3 AU in Dec. 2027 and Sept. 2028. The Apophis Pathfinder mission will be targeted for a rideshare launch that will enable the spacecraft to flyby the asteroid during one of these two opportunities.

The MILO Institute is seeking to increase U.S. and international participation in the Apophis Pathfinder mission. We are especially interested in involving universities, institutes, companies, and/or space agencies that are looking for relatively low-cost and rapid, non-competitive ways to increase their experience base in deep space sensor and payload development, mission operations, and science data analysis. MILO also offers a variety of workforce development programs for students, early career professionals, and others that is designed as a pipeline to help organizations and individuals gain the mentorship and experience needed to move rapidly from science goals to payload definition to deep space mission execution in an affordable and impactful way.

[1] Bell III, J.F., R.S. Park, J.W. Rice, Jr., Y-J. Choi, H-K. Moon, M-J. Kim, M. Jeong, B. Moon, T. Gabriel, D.E. Thomas, 2022, [The MILO Space Science Institute's Apophis Pathfinder Smallsat Mission](#), Apophis T-7 Years (LPI Contrib. No. 2681), 2022.

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