Apophis Rendezvous Mission for Scientific Investigation and Planetary Defense. H.-K. Moon[1], Y.-J. Choi[1], M.-J. Kim[1], Y. JeongAhn[1], H. Yang[1], M. Jeong[1], M. Ishiguro[2], S.-M. Baek[1], J. Choi[1], C. K. Sim[1], D. Lee[1], S.-Y. Park[3], P. Kim[3], S.-J. Kwon[4], G.-H. Shin[4], K.-S. Ryu[4], S.-G. Kim[4], J.-S. Lee[4], J.-G. Seo[4], S.-Y. Kim[4], D.-G. Kim[4], I.-H. Shin[4], S.-O. Park[4], T.-J. Chung[4], G.-S. Shin[4], H.-T. Choi[4], and H.-S. Yoon[5], [1]Korea Astronomy and Space Science Institute (KASI), [2]Seoul National University, [3]Yonsei University, [4]Satellite Technology Research Center (SaTReC), Korea Advanced Institute of Science and Technology (KAIST), and [5]Department of Aerospace Engineering, Korea Advanced Institute of Science and Technology (E-mail: fullmoon@kasi.re.kr).

Introduction: 99942 Apophis is a Sq-type Aten group Near-Earth Asteroid (NEA) with an estimated size of 340 m [1]. Shortly after its discovery when the prediction was based only on relatively few initial observations on hand, this NEA triggered concerns for impact threat. At this period, the prediction suggested a maximum probability of 2.7% that Apophis could be sent into a collision course with the Earth on April 13, 2029 [2]. However, coordinated follow-on astrometric measurements with ground-based optical telescopes and radars to track this object provided significantly improved predictions over the subsequent years, and the possibility of impact in 2029 was removed [3].

Science with Apophis: Apophis will approach the Earth to come within the geostationary orbit during the upcoming encounter. Thus it is expected to offer a unique chance to study either its 1) global properties (shape, surface topography, internal structure, and rotation and spin states), 2) the surface arrangements (regolith and boulder distributions, distributions of space weathered and newly exposed un-weathered regolith on the surface), or 3) their detectable changes expected to happen on the body during the approach [4]. The tidal encounter is expected to trigger varying degrees of observable changes in the dynamics, spin-states, and the surface arrangements of Apophis due to tidal forces caused by Earth's gravity field. The encounter in 2029 is expected to alter its surface topography with material movement such as landslide and mass ejection [5]. Hence the only possible way to quantitatively study tidally induced effects is in-situ measurement by a dedicated space mission aimed at the encounter.

Planetary defense exercise with dedicated in-situ measurements: An asteroid of this size is expected to collide with Earth about every 80,000 years, and could devastate a metropolitan city or a small country. With a dedicated rendezvous mission to Apophis, we should be able to fill in the knowledge gaps in our scientific understanding of tidal effects that could be used for planetary defense when there is a real threat. This is why we propose a rendezvous mission to Apophis. The proposed mission is based on the third revision of the Basic Plan for Promotion of Space Development (2018) of the Korean Government.

Spacecraft platform: There are several options for the spacecraft platform for the mission, including a small scientific satellite bus system with a compact and modular design developed by KAIST. This standard bus system is equipped with an electrical Hall-effect thruster space-proven in low Earth orbit.

Science payloads: We established scientific goals for the proposed mission as described in 'Science with Apophis'; the study of 1) the global properties, 2) the surface arrangements, and 3) their detectable changes predicted to occur on Apophis during the encounter on April 13, 2029. In order to achieve the goals, the science definition team is currently drafting the science requirements for candidate payloads. Our list includes wide/narrow-angle cameras, a multi-band imager, a polarimetric camera (a heritage from PolCam (Wide-Angle Polarimetric Camera) [6] to be onboard KPLO (Korea Pathfinder Lunar Orbiter) [7], a laser altimeter, and a dust particle detector and a magnetometer for cruise operations as options.

Launch windows: We conducted a preliminary mission analysis for the proposed mission, and found that the launch windows in July 2026 and in January 2027 are the most probable opportunities. Our tentative plan is 1) to design (2022-2023), 2) to build, integrate, and test (2024-2026), 3) to launch (2026/27), and to perform 4) science operations (2026/27-2029) with universities, research institutes, and companies in Korea. However, it is opened to overseas institutes for joint scientific studies. One of our current options for the launcher is to use the KSLV (Korea Space Launch Vehicle) series rocket in development.

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