result triggers a further discussion about why Itokawa indicates a moderately fresh spectrum (Sq-type denotes less matured than S-type). For example, Itokawa's smooth terrains show a weaker degree of space weathering than other S-type asteroids [7]. We conjecture that the global seismic shaking caused by collisions with >1 mm-sized interplanetary dust particles induces granular convection, which hinders the progression of space weathering [8]. Note that the efficiency of seismic wave propagation is strongly dependent on the internal structure of the asteroid.

Finally, we consider possible approaches to investigate Apophis's internal structure. The first idea is studying the space weathering age, as conducted for Itokawa. If Apophis indicates a younger age, the internal structure would have more voids [9]. In addition, the 2029 close encounter with Earth provides a rare natural opportunity to witness the contrast between before and after the event. If the asteroid exhibits a slight change in shape and space weathering degree, one can determine the physical structure of the internal materials (e.g., rubble-pile monolithic, thick or thin regolith layer, the cohesion of the materials). We will also consider a possible science using a seismometer.

References

[1] Fujiwara et al., 2006, Science, Volume 312, Issue 5778, p. 1330-1334.

[2] Walsh, 2018, Annual Review of Astronomy and Astrophysics, vol. 56, p.593-624.

[3] Asphaug et al., 2002, Asteroids III, W. F. Bottke Jr., A. Cellino, P. Paolicchi, and R. P. Binzel (eds), University of Arizona Press, Tucson, p.463-484

[4] Brozovic et al., 2018, Icarus, Volume 300, p. 115-128.

[5] Binzel et al. 2009, Icarus, Volume 200, Issue 2, p. 480-485.

[6] Pieters and Noble, 2016, Journal of Geophysical Research: Planets, Volume 121, Issue 10, p. 1865-1884.

[7] Ishiguro et al., 2007, Meteoritics & Planetary Science, vol. 42, Issue 10, p.1791-1800.

[8] Shestopalov et al., 2013, Icarus, Volume 225, Issue 1, p. 781-793.

[9] Richardson et al., 2020, Icarus, Volume 347, article id. 113811.

[구 RMA-05] Rendezvous Mission to Apophis: V. Wide-Angle Camera Science

Youngmin JeongAhn(정안영민)[1], Hee-Jae Lee(이희재)[1], Minsup Jeong(정민섭)[1], Myung-Jin Kim(김명진)[1], Jin Choi(최진)[1], Hong-Kyu Moon(문홍규)[1], Young-Jun Choi (최영준)[1,2]
[1]*Korea Astronomy and Space Science Institute,* [2]*Univ of Science and Technology*

The Korean spacecraft for the exploration of Apophis will be equipped with an optical navigation camera with a wide-angle lens. The major purpose of the wide-angle camera is to capture imagery during the rendezvous phase in order to determine the spacecraft's position and the pointing direction relative to the asteroid Apophis. Two potential sciences, however, can be achieved by the wide-angle camera: (1) to measure the high-order gravity terms, and (2) to capture possible ejecting small particles. In this presentation, we will discuss instrument specification and operation scenario required to accomplish the given science objectives.

[구 RMA-06] Rendezvous Mission to Apophis: VI. Observation Campaign during the 2021 Apparition

Hee-Jae Lee[1], Myung-Jin Kim[1], Dong-Heun Kim[1,2], Hong-Kyu Moon[1], and Young-Jun Choi[1,3] on behalf of the Apophis Observation Team
[1]*Korea Astronomy and Space Science Institute,* [2]*Chungbuk National University,* [3]*University of Science and Technology*

On March 6 2021, Apophis made a close approach to the Earth with a minimum distance of 0.11 AU when the apparent magnitude reached up to V~16. This was the most favorable condition to observe this asteroid until its 2029 encounter. The observations during this apparition were extremely important to determine major physical properties, such as size, rotational state, 3D shape model, surface mineral properties. So, we organized the observation campaign during the 2021 apparition. The main goals of our campaign are to refine the spin state and 3D shape model and check the surface composition variations. The campaign involved dozens of countries and included ground-based photometry and spectroscopy, and spacecraft observations. Our timely observation campaign will provide essential data in planning the operation scenario for the space mission. In this presentation, we will report the preliminary result of the Apophis observation campaign during the 2021 apparition.