K-DRIFT and what we can learn from the K-DRIFT observations.

[구 KDC-07] A novel simulation technique invented for studying low-surface brightness features in and around galaxies: Galaxy Replacement Technique (GRT)

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K-SIM (KASI-Simulation) research project is dedicated to develop new numerical techniques in order to theoretically study galaxy formation and evolution. As the first step of the K-SIM, to model tidal stripping of galaxies with a very high resolution in a fully cosmological context, we invented the Galaxy Replacement Technique (GRT) that is very efficient and fast. The high resolution allows us to accurately resolve the tidal stripping process and well describe the formation of ultra-low surface brightness features in the galaxy cluster (μV < 32 mag/arcsec^2), such as the intra-cluster light, shells and tidal streams. I'll introduce how the GRT is designed and which science topics in low-surface brightness regime can be visited using the GRT.

[특별세션] Rendezvous Mission to Apophis

[구 RMA-01] Rendezvous Mission to Apophis: I. Mission Overview

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An asteroid is important for understanding the condition of our solar system in early-stage because an asteroid, considered as a building block of the solar system, preserves the information when our solar system was formed. It has been continuously flowing into the near-Earth space, and then some asteroids have a probability of impacting Earth. Some asteroids have valuable minerals and volatiles for future resources in space activity.

Korean government clarified, in the 3rd promotion plan for space activity, an asteroid sample return mission by the mid-2030s. However, it is almost impossible to do so based on only a single experience of an exploration mission to the Moon, Korea Pathfinder Lunar Orbiter, which will be launched in mid-2022. We propose a Rendezvous Mission to Apophis(RMA), beneficial in terms of science, impact hazardous, resource, and technical readiness for the space exploration of Korea.

[구 RMA-02] Rendezvous Mission to Apophis: II. Science Goals

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99942 Apophis is an Sq-type Potentially Hazardous Asteroid (PHA) with an estimated diameter of 370 m. It will approach the Earth down to 31,000 km from the surface during the encounter on April 13, 2029 UT, which is closer than geostationary satellites. This once-in-a-20,000 year opportunity would further expand our knowledge on the physical and dynamical processes which are expected to occur due to the gravitational tidal forces when an asteroid encounter with a planet. It will also provide an opportunity to promote great knowledge of the science of planetary defense. The science goal of the Apophis mission is to global-map the asteroid before and after the Earth's approach. In this talk, we will present scientific objectives, and briefly introduce instruments and operation scenarios of the mission.

[구 RMA-03] Rendezvous Mission to Apophis: III. Polarimetry of S-type: For A Better Understanding of Surficial Evolution

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Asteroids have undergone various processes such as impacts, space weathering, and thermal evolution. Because they expose their surfaces to space without atmosphere, these evolutional processes have been recorded directly on their surfaces. The remote-sensing observations have been conducted to reveal these evolutional histories of the target asteroids. For example, crater and boulder distributions are unambiguous evidence for past nondestructive impacts with other celestial bodies. Multiband and spectroscopic observations have revealed space-weathering history (as well as compositions).

Whereas most physical quantities have been examined intensively using spacecraft and telescopes, only a little has been studied on "the grain size". It is one of the fundamental physical quantities for diagnosing the collisional and thermal history of asteroids. Our group has conducted polarimetric research of asteroids (as well as Moon [1]) to determine the particle size and further investigate the evolutional histories of target asteroids [2],[3]. For example, the existence of regolith on an S-type asteroid, Toutatis, was suggested almost twenty years before space exploration [4]. Moreover, we reported that near-Sun asteroids indicate a signature of submillimeter grains, which could be created by a thermal sintering process by solar radiation [5].

However, it is important to note that in-situ polarimetry has not been reported on the asteroid surface, although the Korean Lunar Exploration Program aims to do polarimetry on the lunar surface [6]. Therefore, it is expected that the polarizer mounted on the Korean Apophis spacecraft can make the first estimate of the grain size and its regional variation over the Apophis surface.

In this presentation, we outline research of S-type asteroid surfaces through remote-sensing observations and consider the role of polarimetry. Based on this review, we consider the purpose, potentiality, and strategy of the polarimetry using the onboard device for the Apophis spacecraft. We will report a possible polarization phase curve of Apophis estimated from ordinary chondrites and past observational data of S-type asteroids, taking account of the space weathering effect. Based on this estimation, we will consider the strategy of how to determine the particle size (and space weathering degree) of the Apophis surface. We will also mention the detectability of dust hovering on the surface.

[1] Jeong, M., Kim, S. S., et al. ApJS 221, 1, 16, 2015, [2] Ishiguro, M. et al. Astron. J. 154, 5, 180, 2017, [3] Geem, J. Ishiguro, M. et al. (A&A, under review), [4] Ishiguro, M. et al. PASJ 49, L31, 1997, [5] Ito, T., Ishiguro, M. et al. Nature Comm. 9, 2486, 2018, [6] Jeong, M., Choi, Y.-J., et al. LPICo 1986, 7035, 2017

[구 RMA-04] Rendezvous Mission to Apophis: IV. Investigation of the internal structure – A lesson from an analogical asteroid Itokawa

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Exploration of asteroids' internal structure is essential for understanding their evolutional history. It also provides a fundamental information about the history of coalescence and collision of the solar system. Among several models of the internal structures, the rubble-pile model, confirmed by the near-Earth asteroid (25143) Itokawa by Hayabusa mission [1], is now widely regarded as the most common to asteroids with size ranging from 200 m to 10 km [2]. On the contrary, monolithic and core-mantle structures are also possible for small asteroids [3]. It is, however, still challenging to look through the interior of a target object using remote-sensing devices. In this presentation, we introduce our ongoing research conducted at Seoul National and propose an idea to infer the internal structure of Apophis using available instruments.

Itokawa's research provides an important benchmark for Apophis exploration because both asteroids have similar size and composition [4][5]. We have conducted research on Itokawa's evolution in terms of collision and space weathering. Space weathering is the surface alteration process caused by solar wind implantation and micrometeorite bombardment [6]. Meanwhile, resurfacing via a collision acts as a counter-process of space weathering by exposing fresh materials under the matured layer and lower the overall degree of space weathering. Therefore, the balance of these two processes determine the space weathering degrees of the asteroid. We focus on the impact evidence on the boulder surface and found that space weathering progresses in only 100-10,000 years and modifies the surface optical properties (Jin & Ishiguro, KAS 2020 Fall Meeting).

It is important to note that the timescale is significantly shorter than the Itokawa's age, suggesting that the asteroid can be totally processed by space weathering. Accordingly, our