Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

U02-P01 Room:Convention Hall Time:May 21 15:15-17:00

The Hayabusa return sample curation in JAXA and the first international announcement of opportunity of research

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In the Planetary Material Sample Curation Facility of JAXA, more than 200 particles have been recovered from the sample catcher extracted from reentry capsule of Hayabusa spacecraft, which had returned to the Earth on June 13, 2010. After a series of initial analyses of Hayabusa return samples has finished in November, 2011, some of the sample have distributed to NASA, based on the Memorandum of Understanding (MOU) between Japan and USA for the Hayabusa mission in December, 2011.

Then, information about most of the particles is assembled to the web site for international Announcement of Opportunity (AO) of research for Hayabusa return samples. They are in public from Jan. 21, 2012. Any researcher who has a research plan for the samples can apply to the request for the sample distribution. After a series of referee processes held by the international AO committee, about 100 (maximum) of the sample distribution for the first international AO will start around May, 2012.

Keywords: Hayabusa, Itokawa, asteroid, sample return, planetary material, curation

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Innate Inhomogeneity Inside of Asteroids

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One of the main goals of probe and sample return missions for small solar system bodies is to reveal the nature of asteroids, and eventually, to understand the formation processes of asteroids as well as planets. A great advantage of this approach is that evidences of asteroids/planets formation processes are provided directly based on materials.

Both asteroids and planets are thought to be formed from smaller objects called planetesimals. Thus, if planetesimals have some degrees of inhomogeneity with respect to, for example chemical compositions and isotopic abundance, objects made of planetesimals may have a similar inhomogeneity. When we can observe such an inhomogeneity in the present day asteroids, it may be a clue to reveal the formation processes of those objects.

Here, we evaluate a possible degree of inhomogeneity inside of asteroids using a formation theory. First, we consider the planetesimal formation. Formation process of planetesimals is still under debate, so we employ three different models: gravitational instability model, turbulence driven model, and streaming instability model. These models provide different sizes of first generation planetesimals. Second, we model the formation and growth processes of asteroids. We assume that small asteroids we can see today such as Itokawa and 1999JU3 come from a larger body, 20 km or 100 km in size for instance, and they are fragments of those larger bodies. This implies that the small objects may inherit the inhomogeneity in the large body. Thus, what we need to evaluate is the degree of inhomogeneity in the large body. Based on a standard formation theory of asteroids/planets, 100 km sized body would be formed by collecting material within about 0.01 AU in distance. Since this length is about a hundredth of the semi-major axis of the object, the degree of the inhomogeneity in the body can be as large as one hundredth of the inhomogeneity in the solar nebula itself.

The estimated degree of inhomogeneity should be compared with observational data, which will be obtained by space missions such as Hayabusa-2. If we can find the inhomogeneity with a high precision measurement, it would tell us the formation processes of objects in the solar system.

Keywords: asteroids, internal structure, inhomogeneity

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Photometric Observations of Comet-Asteroid Transition Object 107P/Wilson-Harrington

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A development in recent theoretical studies for the Solar System formation is the suggestion of the Nice model [1]. The Nice model proposes the migration of giant-planets from an initial compact configuration into their present positions. The dynamical evolution of the giant-planets by the Nice model leads to the insertion of primitive trans-Neptunian objects into the outer main belt asteroid (MBA) region [2]. On the other hand, a development in recent observational studies is the discovery of main-belt comets (MBCs) [3]. MBCs are objects that display cometary activities in the MBA region. Six of seven known MBAs inhabit in the outer-MBA region. The mechanism of the cometary activity is controversial: i.e. impact collisions or ice sublimations. A possible activation mechanism for MBCs might be impacts with small (e.g., meter-sized) objects because the long distant from the sun makes ice sublimations difficult to happen. The discovery of MBCs indicates that objects in the outer-MBA region have enough volatile materials, as suggested by the Nice model. Furthermore, some outer-MBAs would migrate to the orbit of near-earth objects (NEOs). A part of such volatile rich objects would impact with the Earth in the earliest stage of the Solar System. The study of objects in which cometary activity is shown provides keys to the origin of Earth's water and life. 107P/Wilson-Harrington (also know as 4015 Wilson-Harrington, hereafter, 107P) was discovered accompanied by a faint cometary tail in 1949. Despite a devoted search, no cometary activity has been detected since the initial observation [4]. Therefore, 107P is a so-called comet-asteroid transition objects. 107P is also categorized near-earth objects (NEOs). A numerical simulation mentions that there is a 65% chance that 107P has an origin in the outer-MBAs region [5]. Thus, 107P might include much volatile material like MBCs. Moreover, if the cometary activity of 107P is driven by impact collisions, the collision would affect the rotation of 107P. In that case, the lightcurve of 107P shows the multi-periodicity. Besides, 107P is a promising target by an advanced asteroid probe. Clarification of the rotational states of 107P is important to design the future sample return mission.

We had conducted the photometric observations of 107P using five small- and medium sized telescopes in 2009-2010 apparition. The lightcurve had showed a periodicity of 0.2979 day (7.15 h) and 0.0993 day (2.38 h), which has a commensurability of 3:1 [6]. We suggest the following four possibilities for the interpretation. 1) 107P is a tumbling object with a sidereal rotation period of 0.2979 day and a precession period of 0.0993 day. 2) 107P is not a tumbler. The sidereal rotation period is 0.2979 day. The period of 0.0993 day represents the roughly symmetrical hexagonal shape. 3) 107P is not a tumbler. The sidereal rotation period is 0.2979 day. The period of 0.0993 day comes from the binary eclipse. 4) The observations were conducted at the phase angle of around 50 degree. Therefore, the shade by topography would provide the period of 0.0993 day. In that case, 107P is not a tumbler. The sidereal rotation period is 0.1490 day (a half period of 0.2970 day). Here, tumbling, binary asteroid, and the topographical effect imply that the cometary activity of 107P results from the impact collisions. The lightcurve that is made at the low phase angle permits us to determine whether the topographical effect is present. We have a plan of next observation campaign of 107P at low phase angle in 2013.

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Keywords: Asteroid, Comet, Observation, Lightcurve

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Geological features of a saturnian small satellite, Helene: implications to the characteristics of E ring.

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Recent Cassini observations have provided numerous high resolution images even of small satellites, which happen to reveal their full varieties in terms of shapes and surface appearances. We are working especially geological aspects of these satellites because (1) there might be unknown processes working between small satellites and saturnian rings; (2) if so, understanding formational and evolutional processes of saturnian satellites may hold important clues to understand those of Saturn system; and (3) small-sized bodies in solar system may have unique surface conditions as indicated by recent missions to small-sized asteroids, satellites, or comets. Also, comparatively very limited (or almost no) researches have been performed for such satellites despite their importance discussed above. Thus, we are trying to unravel specific characteristics of the surface and internal structure of each satellite. We will present initial results of our carefully studies of geological features of Helene, which is located in the E ring regions.

Helene, located at the Dione's leading Lagrangian point and known as one of saturnian trojan satellites, is a poorly-understood satellite with no previous geological studies. Therefore, we first study comprehensive research, such as a shape modeling, crater counting, and detail analyses of surface features. As a result, we find that these features vary widely by regions. For example, the leading hemisphere appears to have smooth surfaces with no small craters or streaky features, while sub-Saturn side of trailing hemisphere shows numerous craters close to saturated. Anti-Saturn side of trailing hemisphere has groove and a lot of craters with the intermediate density. Interestingly, large craters (over ~10km) are uniformly distributed. These crater distributions indicate that the entire bedrock of Helene is quite old and that small craters of leading hemisphere are erased. We conclude E ring materials have contaminated the surface of Helene's leading hemisphere, which resulted in the depletion of small craters as well as formations of streaky features. In addition, we conclude that streaky features are resulted from mass movements and are active even at present time.

Keywords: Helene, Saturn, Satellite, small body, E ring