Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P01 Room:Convention Hall Time:May 19 18:15-19:30

Pronunciations of the names of the minor solar system bodies

Isao Sato[1*]

[1]JANNET

Result of the research of pronunciations of comets, asteroids, and satellites in 20 years are presented. Especially, hearing research of pronunciation of the comets appeared in the past are completed. Pronunciation of named asteroids are researched for more than a half of them.

Keywords: minor solar system bodies, pronunciation


Vol. 3, No. 4. THE ASTRONOMICAL HERALD July 1910
Published by the Astronomical Society of Japan.
天文月報
明治四十三年七月 第三巻第四號
ハリー彗星
一戸直藏

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P02 Room:Convention Hall Time:May 19 18:15-19:30

Ground calibration impact experiments on arrayed large-area dust detector for interplanetary space onboard IKAROS

Chisato Okamoto[1*], YANO, Hajime[1], TANAKA, Makoto[2], HIRAI, Takayuki[3], HASEGAWA, Sunao[1], TABATA, Makoto[1], OGAWA, Junko[1], IWAI, Takeo[4], OKUDAIRA, Kyoko[5]

[1]Japan Aerospace Exploration Agency, [2]Tokai University, [3]The Graduate University for Advanced Studies, [4]Tokyo University, [5]The University of Aizu

IKAROS (Interplanetary Kite-craft Accelerated by the Radiation of the Sun) was successfully operated beyond its nominal operational period of 3-6 months from its launch in May of 2010, in deep space between the Earth and Venus orbits. Arrayed Large-Area Dust Detectors in INterplanetray Space (ALADDIN) were attached on the anti-Sun face of its 7.5-micron thick polyimide sail membrane of IKAROS. The dust detectors are made up of 8 channels of 9-20 micron-thick PVDF (ALDN-S) with effective detection area of 0.54m2 to detect hypervelocity impacts of micrometeoroids. Impact signals from PVDF are sent to electronic unit which filters thermal and vibration noises and records impact time, peak voltage and relaxation duration of each impact signal.

ALADDIN continuously measured heliocentric flux variance of cosmic dust from inside the orbit of the Earth to the vicinity of Venus in 2010-2011. The flux trends is well consistent with the data of Helios in 1970's and Galileo in 1990's. We conducted ground calibration impact experiments to evaluate cosmic data from ALADDIN. Impact experiments simulating collision of micrometeoroids on ALDN-S were performed using two-stage light gas gun at JAXA. We obtained impact signals on PVDF at various particle sizes and impact velocities.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P03 Room:Convention Hall Time:May 19 18:15-19:30

Geological features and surface processes on saturnian small satellites

Naoyuki Hirata[1*], Hideaki Miyamoto[1]

[1]The University Museum, The University of Tokyo

Gas giants have numerous small satellites, which are expected to have environments similar to asteroids and comets in terms of such as the tiny gravity, icy surface compositions, and the deficiency in endogenic processes. Therefore, studies of these small satellites can contribute to understand the evolutions of asteroids and comets and can be regarded as an important clue of formations and evolutions of solar system and gas giant systems. After Cassini arrivals at Saturn in 2004, Cassini obtains numerous high-resolution images of Saturnian small satellites. In this presentation, based on our finding and analyses, we focus on the geological features and surface processes of Pan, Daphnis, Atlas, Janus, Epimetheus, Methone, Pallene, Telesto, Calypso, and Helene.

Pan, Daphnis, and Atlas are located at the main ring region, which holds the satellite system with the most inner orbit of the Saturn system. Their shapes are close to a disc-like ellipsoid, which is explained to be formed by the accumulation of main ring particles. Their surfaces show an unusual smoothness without craters or grooves. We newly find the existence of an impact crater on Atlas through our detail investigations. In addition, based on theoretical studies of electrostatic environments, their surfaces have the electrostatic potential enough to levitations of a particle on the surface due to the repulsion forces of electrostatic forces. As a result, we conclude that these satellites may have the resurfacing process due to dust levitation.

Helene is located at the E ring region, whose orbit is known as the leading trojan orbit of Dione. We find that this satellite has a hemispheric dichotomy; its trailing hemisphere has numerous impact craters close to the saturated-condition, while its leading hemisphere is deficient of impact craters. Also, the leading hemisphere of Helene shows numerous gully-like depressions. We develop the shape and gravitational conditions of Helene, where we find that these gully-like depressions strictly follow the local gravitational slopes ranging from 7 to 20 degrees. This indicates that these features are depositional and formed by gravity-induced mass movements. Also, these hemispheric dichotomy can be explained by the accumulations of the E ring materials erupted by the cryovolcanic activity of Enceladus. We find that Telesto, Calypso, Pallene, and Methone, which are also located at the E ring region, are also affected by the E ring, as well as Helene. As a result, based on the total amount and the density of craters on the E ring deposits of satellites, we conclude that the cryovolcanic activity on Enceladus has a short lifetime, possibly only several My.

Janus and Epimetheus are small inner satellites known as the co-orbital satellites. Their surfaces have numerous impact craters with near-saturated conditions, which indicates that these objects are old satellites in Saturn system. Through detailed investigations of high-resolution images, we newly find both satellites consist of the distinct two terrains, such as dark and bright terrains. The dark terrains distribute on the gravitational lowlands and each dark terrain is isolated over all the satellite, which shows the pond-like appearance. The difference between the nature of dark terrains of Janus and Epimetheus cannot be identified in terms of (1) a surface flatness or smoothness, (2) an albedo, which is darker than surrounding bright terrains, (3) an existence as deposits on lower land, and (4) a sharpness of the boundary between darker terrains and surrounding bright terrains. We find that almost all dark terrains on Janus appear to exist at the equatorial region of anti-Saturn side and almost all dark terrains on Epimetheus at the south polar region. As a result, we conclude that these distributions of dark terrains can be explained by the coefficient with the Janus-Epimetheus ring system.

Keywords: Saturn system, small satellite, ring, geological feature

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P04 Room:Convention Hall Time:May 19 18:15-19:30

Cratering experiments of porous surface in strength regime using low density impactors

Shunya Harada[1*], Takaya Okamoto[1], Takanobu Aoki[1], Akiko Nakamura[1]

[1]Graduate School of Science, Kobe University

The Cassini spacecraft has obtained the high resolution images of small impact craters of saturnian satellites. Some of the satellites have low mean density, ~1 g/cm^3, so these are considered to be the ice-rock bodies. For example, Iapetus has a density of ~1.1 g/cm^3 and has been taken images of the surface by Cassini down to the resolution limit of ~10 m/pixel.

The surface of these bodies is considered to have been covered with regolith layer formed by fallen debris of impact ejecta. The layer gained porosity in the reaccumulation process. If the regolith layer contains fine icy debris, it would have strength by sintering. It is likely that temperature increase or compaction due to further impact advances sintering of regolith layer.

In this study, we conducted cratering experiments to investigate the cratering formation process on porous surface in strength regime. In order to prepare targets with different porosity and strength, we sintered 55 micron diameter hollow sphere soda-lime borosilicate glass with varying sintering temperature to attain porosity of 73-94% and strength of 0.6-1.9MPa. Impactors were sintered soda-lime borosilicate glass spheres (~1.3 g/cm^3) and porous alumina spheres (~1.8 g/cm^3) to simulate low density bodies. Impact velocity was 100-300 m/s. We used a small gas gun at Kobe University in this study.

In this study, penetration hole was formed on the target of porosity 94%. Hole depth decreased as target porosity decreased and finally a bowl-shaped crater was formed on the target of porosity 74%. On the other hand, hole diameter was constant and approximately the same with the diameter of the projectile over the parameter range of this experiment.

We will compare the results with previous study and discuss the cratering formation process on porous surface of small bodies.

Keywords: porosity, strength, ice-rock body, satellite, impact experiment

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P05 Room:Convention Hall Time:May 19 18:15-19:30

Present status of international announcement of opportunity for research of Hayabusa-returned samples

Toru Yada[1*], Masanao Abe[1], Tatsuaki Okada[1], Masayuki Uesugi[1], Yuzuru Karouji[1], Yukihiro Ishibashi[1], Shogo Yakame[2], Masaki Fujimoto[1], Makoto Yoshikawa[1]

[1]Japan Aerospace Exploration Agency, [2]Graduate school of Science, University of Tokyo

Since Hayabusa spacecraft returned its reentry capsule to the Earth in June 2010, particles captured in its sample catcher have been recovered and described initially by an optical and an electron microscope [1].

Some parts of the described particles were distributed to the Hayabusa sample preliminary examination team (HASPET) and analyzed for their chemistries, tomographies, mineralogies, and oxygen isotope compositions to be indicated that they were comparable to equilibrated LL chondrites [2-5]. They were also analyzed by a transmission electron microscope (TEM) and showed amorphous textures on their surface layers caused by space weathering [6]. Additionally, they were analyzed by a noble gas mass spectrometer and clarified that they had been exposed to solar and galactic cosmic ray and their duration were supposed to be short as less than 3Ma [7]. All of these results indicate that the silicate particles recovered from the catcher originated from the asteroid Itokawa.

Total number of recovered and initially described particles counts up to 430 thus far. Three fourths of them are silicate particles, which are supposed to be originated from Itokawa. We have not recovered particles totally from the catcher yet, and are planning to finish total sample recovery in the middle of fiscal year of 2015.

Based on the memorandum of understanding agreed with NASA, 15% of the recovered samples should be distributed for international announcement of opportunity (AO) for research. JAXA organized the international AO committee and the committee published the first international AO from Jan. to Mar. in 2012. 17 research groups from seven countries were selected for the AO research in Jun. 2012 and totally 65 Itokawa particles had been distributed to them until Nov. 2012. Thus far, they are under investigation and their results will be presented in the first Symposium of Hayabusa, extraterrestrial material and exploration, planning to be held in JAXA Sagamihara campus in Oct. 2013. And the second international AO has been published from Jan. to Mar. 2013. Selected research groups will be announced in Jun. 2013, and their sample distribution will be performed until the end of Aug. 2013.

References: [1] Yada T. et al. (2013) Meteoritics Planet. Sci., in print. [2] Nakamura T. et al. (2011) Science, 333, 1113. [3] Yurimoto H. et al. (2011) Science, 333, 1116. [4] Ebihara M. et al. (2011) Science, 333, 1119. [5] Tsuchiyama A. et al. (2011) Science, 333, 1125. [6] Noguchi T. et al. (2011) Science, 333, 1121. [7] Nagao K. et al. (2011) Science, 333, 1128.

Keywords: Hayabusa, Itokawa, curation, international announcement of opportunity, meteorite, LL chondrite

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P06 Room:Convention Hall Time:May 19 18:15-19:30

Analysis of The Asteroid Itokawa Surface Spectra Using Principal Component Analysis

Sumire Koga[2*], Kazuhiro Isashiki[1], Seiji Sugita[2]

[1]Dept. Sci., Univ. Tokyo, [2]Dept. Complexity Sci. and Engr. Univ. Tokyo

Analysis of Asteroid Itokawa Surface Spectra Using Principal Component Analysis

Objective

The Hayabusa Spacecraft Asteroid Multi-band Imaging Camera (AMICA) obtained high spatial resolusion images of asteroid Itokawa.

In this study, we performed principal component analysis (PCA) using these multi-band images of Itokawa.

Such analysis method is usuful for analysis of Hayabusa-2 as well as First Hayabusa.

Methods

A series of images taken from approximately the same position were used for analysis. They were calibrated, ratio images of the calibrated image were made and used for PCA. PC coefficients and the proportion of variance was calculated. Also, the correlation between curvature (Cv) and inclination (Rw /Rb) of the reflectance spectrum, each of which is known as one of indice of space weathering, is confirmed.

Results and discussion

The proportion of variance of PC1 and PC2 was calculated to be about 60-70 % and 20-30 %.

It was conjectured that PC1 means the degree of spaceweathering from its coefficients, and was also implied to be plausible by matching to Previous resurch[1]. However, the significance of PC2 is not clear yet. Possible candidates are heterogeneity in composition, particle size, noise, or effect of the incompleteness of corregistration.

A positive correlation between Cv and Rw/Rb were found. However, the correlation is not very tight; further study for the large scatter is needed.

There are dark boulders called ”Black Boulders” on the ”head” of Itokawa[3]. While the other parts made one cluster in PC1 vs PC2 plot, the Black Boulder was ploted out of the main cluster. It is a good example that shows the effectiveness of PCA.

Conclusion and future work

We performed PCA for the Itokawa surface spectra. It was well implied that PC1 means the degree of space weathering. PC1 vs PC2 plot let us find that Black Boulder is peculiar easily. These shows the effectiveness of PCA. Though the meaning of PC1 is easy to understand, we have to examine what PC2 means.

References

[1] Ishiguro et al. 2007, MAPS 42, 1791.
[2] Ishiguro et al. 2010, Icarus 207, 714.
[3] Hirata & Ishiguro 2011, 42nd LPSC (2011).

Keywords: asteroid, visible spectroscopy, space weathering

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P07 Room:Convention Hall Time:May 19 18:15-19:30

Scientific observation plan for Hayabuasa-2 visible muti-band cameras

Seiji Sugita[1*], Rie Honda[2], Shingo Kameda[3], Tomokatsu Morota[4], Hirotaka Sawada[5], Chikatoshi Honda[6], Hidehiko Suzuki[3], Kazunori Ogawa[5], Kei Shirai[5], Manabu Yamada[7], Ryosuke Nakamura[8], Hayabusa-2 ONC Science Team[5]

[1]University of Tokyo, [2]Kochi University, [3]Rikkyo University, [4]Nagoya University, [5]JAXA, [6]Aizu University, [7]Chiba Institute of Techonology, [8]AIST

The Hayabusa-2 spacecraft will carry an optical navigation camera (ONC) system, consisting of a telescopic camera (ONC-T) with a filter wheel and two wide-angle cameras (ONC-W1 and -W2). We are planning to conduct a variety of scientific observation of the target asteroid 1999JU3 using ONC from a wide range of distances, including the home position (˜20 km) to a touch down on the asteroid surface. This paper summarizes the ONC science observations, particularly multi-band imaging spectroscopic observations based on recent ground-based telescopic observations of the mission target asteroid.

Keywords: asteroid mission, primitive bodies, Hayabusa-2 mission, remote sensing, reflectance spectroscopy, instrument development

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P08 Room:Convention Hall Time:May 19 18:15-19:30

Calibration of Asteroid Explorer Hayabusa-2 ONC (Optical Navigation Camera)

Masaki Sato[1*], TAKEI, Akito[1], Yuichiro Cho[2], Hidehiko Suzuki[1], Manabu Yamada[3], Shingo Kameda[1], Hayabusa2 ONC team[4]

[1]Rikkyo University, [2]The University of Tokyo, [3]Chiba Institute of Technology, [4]JAXA

The Asteroid Explorer Hayabusa succeeded in returning samples from the S-type asteroid Itokawa. Building upon the technology obtained by Hayabusa, its successor, Hayabusa-2, will visit the C-type asteroid 1999JU3.

One of the differences between S-type and C-type asteroids is the degree of thermal metamorphism present in the asteroid, with a lesser degree of metamorphism in C-type asteroids. From this perspective, a C-type asteroid is a more primitive body and is considered to contain more organic or hydrated minerals. Hayabusa-2 will retrieve samples from the surface of asteroid 1999JU3, which are predicted to be consistent of the non-advanced metamorphic nature of C-type asteroids.

Reflectance spectra of asteroid 1999JU3 were acquired from ground-based observations. These show an absorption feature centred near 700 nm that is commonly seen in hydrated minerals. However, it is possible that hydrated minerals are not distributed throughout the asteroid's surface. To select a suitable landing point, it is necessary to observe the presence or absence of absorption features centred near 700 nm even after the launch to identify areas containing hydrated minerals.

Observations for the landing point selection will be conducted using an Optical Navigation Camera (ONC). An ONC contains three cameras, ONC-W1, ONC-W2, and ONC-T. ONC-W1 and ONC-W2 are wide-angle cameras, and ONC-T is a telescopic camera. In ONC-T, there is a filter wheel, which consists of seven bandpass filters (390 nm, 480 nm, 550 nm, 589.5 nm, 700 nm, 860 nm, 950 nm) and a sheet of glass. Rotation of this filter wheel facilitates spectroscopic observations. A suitable landing point will be selected based on these observations.

In preparation for the optical calibration test of the flight model, we prepared the calibration camera and filter for the ONC. After calculating the luminance on the surface of 1999JU3 and measuring the filter transmittance, we conducted sensitivity calibrations, and flatness measurement and determined the point spread function (PSF) as preliminary experiment.

Based on these preliminary experiments, we conducted the optical calibration test of the flight model. This presentation will show the result of the preliminary experiments and the optical calibration test of the flight model.

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P09 Room:Convention Hall Time:May 19 18:15-19:30

An observation performance study of NIRS3 on Hayabusa-2 based on low temperature examination data for InAs detector

Yusuke Nakauchi[1*], Kohei Kitazato[2], Takahiro Iwata[3], Shuji Matsuura[3], Makiko Ohtake[3], Masanao Abe[3]

[1]The Graduate University for Advanced Studies School of Physical Sciences, [2]University of Aizu, [3]JAXA

The Near Infrared Spectroscopy (NIRS3) will be equipped to survey hydrated mineral on an asteroid in the next mission : Hayabusa2. It will provide the data for selecting the sampling positions, making global map of abundance of water and observing difference of surface minerals. The reflectance spectra of minerals have absorption features in the visible and near infra-red region. For example, near 2.7um region has many absorption features related to hydroxyl stretching and H_2O bending, and near 1.9um and 3.0um region have bending of molecular H_2O. The absorption near 1.9um is weaker than near 3.0um. In addition, the feature near 1.9um is more vulnerable to heat than near 3.0um.

One of the scientific objective of the NIRS3 is to determine the amount of water and hydrated minerals. It requires the enough quality for remote sensing to extract both strong and weak absorption features from the data, thus we designed the signal to noise ratio (SNR) of more than 50.

This SNR mainly depend on performance of devices. The performance of InAs linear image sensor used NIRS3 has been measured in the factory, however the operating temperature during the measurement was higher than estimated actual one. So we confirmed performance of engineering model (EM) and flight model(FM) under -70^{o}C.

The total performance of observation of NIRS3 has been considered based on environmental test for EM sensor until now, and the SNR has not reached 50. The major factor in decreasing SNR is fluctuation in the dark current. If we could not achieve that required SNR, we were required changing the sampling methods of signal or optical design or temperature setting.

Recently, the FM sensor was supplied and we did same test with EM sensor. This examination shows that FM sensor has smaller noise and dark current than EM's. Furthermore, the deference of FM sensor arrays sensitivity was smaller than EM's. Thus we compared the quality of EM and FM, and considered SNR which will be obtained on mission.

Keywords: Hayabusa-2, NIRS3, asteroid, 1999JU3, spectro, near infrared

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P10 Room:Convention Hall Time:May 19 18:15-19:30

Measuring Albedo of C-type Asteroid with LIDAR onboard HAYABUSA2 Spacecraft

Shinsuke Abe[1*], Fumi Yoshida[2], Hirotomo Noda[2], Ryuhei Yamada[2], Sho Sasaki[2], Noriyuki Namiki[3]

[1]Department of Aerospace Engineering, College of Science and Technology, Nihon University, [2]National Astronomical Observatory of Japan, [3]Planetary Exploration Research Center, Chiba Institute of Technology

Hayabusa-2 is an asteroid sample return mission of JAXA/ISAS (Japan Aerospace eXploration Agency/Institute of Space and Astronautical Sciences) which will be launched in 2014, will explore a near-Earth asteroid (162173) *1999 JU3* in 2018, and will back to the Earth in 2020. LIDAR (laser altimeter) is one of five instruments onboard *Hayabusa-2*, and is used to measure distance between the spacecraft and the surface of the target asteroid. LASER pulse measuring from 25km to 30 m distances emits at the wavelength of 1.06 micron. LIDAR will be used as not only navigation instrument on the spacecraft but also scientific experiments such as measuring local landscape, albedo, dusts, gravity and shape of the asteroid.

Considering ground-based spectroscopic & lightcurve observations of *1999 JU3*, other C-complex main-belt asteroids, and laboratory experiments of carbonaceous chondrites, several science topics related to albedo of C-type asteroid obtained by LIDAR and other instruments onboard *Hayabusa-2* will be discussed. For example, surface albedo heterogeneity, space weathering, and associated main-belt asteroid families. Albedo heterogeneity of S-type asteroid Itokawa obtained by LIDAR and NIRS (Near-InfRared Spectrograph) on *Hayabusa-1* will be shown.

Keywords: asteroids, Hayabusa, LIDAR, albedo, space weathering, carbonaceous chondrites

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P11 Room:Convention Hall Time:May 19 18:15-19:30

Development of MASCOT (Mobile Asteroid Surface Scout) small lander on Hayabusa2

Tatsuaki Okada[1*], HO, Tra-Mi[2], MASCOT team[2]

[1]Institute of Space and Astronautical Science, JAXA, [2]German Aerospace Center

The small lander MASCOT (Mobile Asteroid Surface Scout) is being developed for HAYABUSA2 under the international collaboration among DLR (Germany), CNES (France), and JAXA (Japan). It aims to investigate with high accuracy and spatial resolution the surface geomorphology, the minute structure, texture and composition of rocks, and the thermal and magnetic properties of C-class asteroid. Characteristics and status of the lander is briefly reported.

MASCOT has been tested for its performance, functions, and torelance under mechanical and thermal-vacuum enviromental conditions using Engineering model. It has been verified in component tests as well as initial integration test of Hayabusa2.

A 10kg-class lander is being considered with 3kg for science instruments. A wide angle multi-band imager CAM and a visible-infrared hyperspectral Microscope MicrOmega, multi-wavelength thermal radiator MARA, and fluxgate magnetometer MAG are the science payloads. With these instruments, the lander will conduct its stand-alone surface science of geology and geophysics, obtain geologic context for sample return, and measure composition and mineralogy as groundtruth for remote sensing. The lander will strengthen and complete the science of HAYABUSA-2 complementary to remote sensing and analysis of returned samples.

Keywords: Hayabusa2, asteroid, lander, hyerspectral microscope, thermal radiometer

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P12 Room:Convention Hall Time:May 19 18:15-19:30

Dynamical simulation of microgravity rovers

HARADA, Toshihiro[1], Kohei Kitazato[1*]

[1]University of Aizu

We developed a dynamics simulator of microgravity rover for small body exploration. Surface exploration using rovers are expected to return scientific discoveries yet to be made, and for them the global and long-term operations and tactical planning are needed. However, gravity fields of small bodies are not uniform due to their irregular shapes so that it is difficult to analytically predict the rover's motion. Thus, physical-based simulation for microgravity rovers is required.

We designed the simulator to have functions to estimate the rover trajectory based on rigid-body dynamics and to visualize the trajectory data on the shape model of small body. The graphical interface has been built in to support the usability. In addition, we performed a comparative experiment in laboratory to verify the simulation of rigid-body's rebound motion.

Finally we examined characteristics of rover motion using Itokawa's shape model. As a result, we found that the rover's motion would converge for shape models of less than approximately 5-m resolution.

Keywords: simulation, dynamics, rover, Hayabusa-2

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P13 Room:Convention Hall Time:May 19 18:15-19:30

A study on a low-cost deep space exploration mission utilizing a small kick stage

Toshinori Ikenaga[1*], UTASHIMA, Masayoshi[1], ISHII, Nobuaki[1], Makoto Yoshikawa[1], HIRAIWA, Tetsuo[1], NODA, Atsushi[1]

[1]Japan Aerospace Exploration Agency

This study aims to realize low-cost deep space exploration missions utilizing dual launch system equipped with a small kick stage, and flexible orbit design method using a concept of interplanetary parking orbit.

In this study, it is assumed that 800 kg dual launch system consisting of 500 kg deep space explorer and 300 kg small kick stage is launched together with a primary payload into geo-stationary orbit, GTO, whereupon the small kick stage is initiated at perigee to inject the deep space explorer i.e. Mars explorer into an orbit whose orbital energy, C3, is almost zero. Then the on-board ion engine system, IES, accelerates the explorer through the electric delta-V Earth gravity assist, EDVEGA, scheme to increase the Earth relative velocity at the Earth re-encounter point, which enables the explorer to inject into Mars transfer orbit after the Earth gravity assist. The Japanese H-2A 206 has ability to launch a 6 ton payload into GTO, accordingly, the 800 kg dual launch system assumed in this study can be launched together with about 5 ton of primary payload.

Throughout the simulations conducted in this study, it is revealed that the assumed dual launch system can send the 500 kg deep space explorer equivalent to HAYABUSA-2 to Mars. The dual launch system suggested in this study has possibility to decrease the cost and increase the opportunity of deep space exploration missions. However, the launch window, which is critical for deep space missions, is severely constrained in this launch configuration because the launch epoch is determined by the requirement of the primary payload. To solve this problem, this study suggest a concept of interplanetary parking orbit to increase the flexibility of deep space orbit design and to widen the launch window.

Keywords: small kick stage, dual launch system, low-cost deep space exploration, electric propulsion, interplanetary parking orbit

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P14 Room:Convention Hall Time:May 19 18:15-19:30

Asteroid Shape Reconstruction using Structure from Motion

Yohei Mori[1*], Naru Hirata[1], Hirohide Demura[1]

[1]The University of Aizu

A shape model of an asteroid is important for science analysis on exploring missions. In the Hayabusa mission, three models of asteroid Itokawa were reconstructed by different methods [M. Maruya, 2006], [H. Demura, 2006], [R. Gaskell, 2006]. A more precise model was reconstructed that have 3 millions or more polygons used multi-image photoclinometry after the mission [M. Maruya, 2006]. For the Hayabusa 2 project, a shape model of an asteroid 1999JU3 is also required. It must be investigated what reconstruction method is good. We focus on a method called Structure from motion (SfM) to achieve it. An open-source software Bundler [N. Snavely, 2006] implements SfM and Bundle adjustment [B. Triggs, 1999]. SfM is a method which uses multiple images to estimate real space coordinates of features in images and camera positions. Bundle adjustment is a kind of optimization method for non-linear model to estimate parameters on a geometric model precisely. A more precise result and less manual works are expected compared with ones in the Hayabusa mission by using and customizing the software. We reconstructed a shape model of Itokawa from 169 AMICA Images using this software. As a result, a sparse shape model is reconstructed successfully around equatorial region. However the number of points of polar regions are quite less than ones of equatorial region. This is caused by an insufficiency of images captured around a pole. We experimented this polar area observations using a shape model presented by [R. Gaskell, 2006]. In this experiment, we rendered the model and take images around of it with some longitude variations. One of the dataset is consists of images view from 30 degree longitude. The polar region is reconstructed successfully by inputting the dataset. And we also experimented with 70 degree and 80 degree longitude datasets for confirming the availability of Structure from Motion in the case of the rotation axis of 1999JU3 is parallel to the plane of revolution. The result was also good. Structure from Motion is useful for reconstructing asteroid shape model from multiple images. We are examining a method for quantitative evaluation of these results.

Keywords: Hayabusa, Hayabusa 2, 3D Shape Reconstruction

Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)

U07-P15 Room:Convention Hall Time:May 19 18:15-19:30

Gravity Estimation in Hayabusa2 Mission

Hitoshi Ikeda[1*], Koji MATSUMOTO[2], Hayabusa2 LIDAR Science Team[3], Hayabusa2 Astrodynamics Team[4]

[1]Japan Aerospace Exploration Agency, [2]National Astronomical Observatory of Japan, [3]Hayabusa2 LIDAR Science Team, [4]Hayabusa2 Astrodynamics Team

The Japanese asteroid explorer Hayabusa2 will be launched in the mid-2010s to return samples from C-type near earth asteroid 1999JU3. During the rendezvous phase (i.e., proximity operation phase), we will make scientific observations to estimate physical parameters (e.g., gravity field, shape, pole direction, spin-rate, ephemeris) of the target body, which are very important not only for its scientific investigation but also for the spacecraft navigation. In particular, the mass is essential to perform a stable touch down sequence to collect samples from the asteroid's surface. We will attempt to estimate the gravity field of the target body using earth-based radiometric tracking measurements (2way Doppler and range) and spacecraft-based measurements (information from optical navigation camera and laser altimetry) with global parameter estimation technique. As the first step for the gravity field estimation, we performed a simulation study about mass estimation under simple configuration and evaluated the relation between the quality and quantity of measurements and the accuracies of estimation results. The detectability of the low degree and order gravity field coefficients is also investigated.

Keywords: gravity, orbit, small-body