Japan Geoscience Union Meeting 2015
(May 24th - 28th at Makuhari, Chiba, Japan)

PCG30-P01 Room:Convention Hall Time:May 26 18:15-19:30

Pre-launch calibration and the first image data of the optical navigation camera of Hayabusa 2

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Introduction: The optical navigation camera (ONC) system of Hayabusa 2 consists of three CCD cameras (T, W1, and W2). By taking images of both the mission target asteroid 1999JU3 and the star field, it navigates both the spacecraft and its scientific observations. Because of its high spatial resolutions and global coverage, it is expected to provide geologic context to other science instruments on Hayabusa 2.

As a part of optical calibration for the cameras, we conducted end-to-end tests to observe objects similar to the actual observation targets under conditions close to the actual flight situations are very effective.

ONC-T: Because the 0.7 μm absorption band is one of the most important observation targets of ONC-T multi-band imaging, we examined whether the actual ONC-T flight model can detect 0.7 μm absorption band of carbonaceous chondrites samples. The experimental results indicate that all the multi-band images of the former five CM samples clearly indicate the presence of 0.7 μm absorption and that that for Jbilet Winselwan, which is a CM chondrite with no 0.7 μm absorption, indicates the absence of the absorption. This result unambiguously shows that ONC-T can detect the 0.7 μm band if its strength is about 3%.

ONC-W1: The experimental results indicate that large and bright CAI's in CV meteorites are discernible. Although individual condrule fragments in CM meteorites are too small to resolve with W1 even at proximity, the gradual brightness undulation due to the inhomogeneous distribution of chondrule fragments are discernible in W1 images. Because spatial inhomogeneity in CM chondrites are may be due to impact brecciation on their parent body, observation of such brightness distribution might be useful for understanding the mechanical history of the asteroid surface.

First Light of ONC: Soon after the launch, an image of the Moon was obtained with the W2 camera at ~50-deg of solar phase angle. This became the first light of ONC system. A preliminary analysis based on the brightness recorded in the image and pre-flight calibrations indicates that the apparent reflectance of the Moon is about 7%. The data by the Multi-band Imager (MI) onboard KAGUYA indicate that typical visible range (415 ? 1000 nm) reflectance for lunar highlands are 4.5 ? 10.7 % for 50-deg of solar phase angle. This agreement between W2 and MI suggests that the W2 camera has been calibrated properly and is functioning properly.

Keywords: asteroid, planetary exploration, Hayabusa 2 mission, Multi-band imaging

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Accuracy Evaluation of Asteroid Shape Reconstruction by Structure-from-Motion Method with a asteroid scale model

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Here we report results on application of open source shape reconstruction tools to an asteroid image data set. We test two tools that cooperatively work to reconstruct an object shape from images. Bundler is an open source implementation of a stereo shape reconstruction method called Structure from Motion (SfM). PMVS2 gives a more dense shape model, since Bundler only estimates 3D locations of a limited number of feature points. The target of our test is a scale model of an asteroid. The shape of the model is accurately measured by a laser scanner, and this shape data is used as a reference to evaluate a shape model obtained by Bundler and PMVS2 from imaged of the scale model. This procedure is more appropriate to evaluate in a more objective way than our previous procedure (Hirata et al., 2014, JPGU meeting), because two shape models are independently obtained with different methods.

Keywords: Asteroid, shape reconstruction, bundler, PMVS2, Structure-from-Motion, Hayabusa-2

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Results of the development for NIRS3: the Near Infrared Spectrometer on Hayabusa-2

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NIRS3: the Near Infrared Spectrometer is one of the candidate scientific instruments which will be equipped on Hayabusa-2 mission. It aims to observe near infrared spectroscopy at the wave length band of 1.8-3.2 micrometer to detect specific molecular absorption lines, including the absorption by hydrated minerals at 3 micrometer, on the target C-type asteroid. We implemented ground performance tests using the flight mode of the Spectrometric Unit (NIRS3-S) and the Analogue Electric Unit (NIRS3-AE). Infrared rays from the black body source are reflected by the sample and two gold mirrors in a vacuum desiccator, and then injected into NIRS3-S which is refrigerated at -60 to -90^{o}C in a vacuum cryostat. The black body source emission is directly injected into NIRS3-S during amplitude-calibration tests. Lights from a halogen lamp are injected into NIRS3-S through a monochromator during frequency-calibration tests. NIRS3-AE controls the inner calibration lamps, the chopper, and data acquisition by the sensor in NIRS3-S.

Results of flight-model tests implied that the dark current at the InAs sensor is much lower than that of the engineering model, which improves the signals-to-noise ratio (SNR). The projected on-board SNR was confirmed to be sufficient during the one-year observation period of Asteroid 1999JU3 assuming the surface temperature estimated from the heliocentric range and solar phase angle. The SNR exceeds 300 after 2.5 ms integration and 1024-stacking at the home position observations. It exceeds 60 after 1 ms integration and 64-stacking for the observations of artificial crater made by the Small Carry-on Impactor (SCI) on Hayabusa-2. The data obtained after the vibration tests and thermal-vacuum tests indicate that NIRS3 is sufficiently durable for the launching and on-orbit environments. The observed spectra for samples of serpentine, olivine, and CM-chondrites such as Murchison, Murray, and Jbilet Winselwan demonstrated that the derived reflectances are almost the same as those obtained by Fourier-transform infrared (FTIR) spectroscopy. These results show that NIRS3 has sufficient performance for scientific objectives. We will also report the first results on Hayabusa-2 after the launch.

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

PCG30-P04 Room:Convention Hall Time:May 26 18:15-19:30

Initial operation of Hayabusa-2 laser altimeter (LIDAR)

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Introduction: As a successor of Japanese Hayabusa Asteroid mission, Hayabusa-2 was successfully launched on 3 December 2014. The target asteroid of Hayabusa-2 is now called 1999 JU_3, which has C-type spectral type. C-type asteroids are considered to be more primitive than S-type asteroids because of its further heliocentric distance, and to be good targets to know the origin and the history of the solar system.

As a part of the Attitude and Orbit Control Subsystem (AOCS), the laser altimeter called LIDAR is developed. LIDAR measures altitudes of the spacecraft from a surface of the asteroid by detecting a time of flight of bounced laser pulse on the asteroid surface. Basically the LIDAR data are used for navigation of the spacecraft, and they are particularly important during touch-down operation. Besides, the LIDAR data will be served for scientific analysis of the shape, mass, and surface properties of the asteroid in order to elucidate physical evolution of minor bodies such as impact fragmentation and coagulation.

In addition to the normal ranging mode, LIDAR of Hayabusa-2 is equipped with dust counting mode and laser transponder mode. The levitation dusts above the asteroid, if they exist, can be measured along the line of sight direction of the LIDAR in dust counting mode. The laser transponder mode is used for the demonstration of the optical data transmission from the spacecraft to the ground laser station and vice-versa, when the spacecraft is near the Earth for the Earth gravity assist operation in winter 2015.

Operation history: After the launch, the LIDAR was turned on for the first time on 15 December 2014 for the confirmation of the power consumption and thermal environment of the instrument. On 23 January 2015, detailed function test was done. On this day, all the necessary commands were issued and all observation modes were used. The whole ranging system was checked by turning on the laser and the detector unit for the first time after the launch. Because no ranging target is available during the cruise phase, each function was checked separately. First, the laser power is confirmed to be normal. Then, the high voltage of the APD (Avalanche Photo Diode) detector was applied properly, which was compensated with the temperature of the APD to stabilize the sensitivity. Also, the noise level of the APD was checked by changing the threshold level of the detectable signal. Lastly, the range-finding circuit was intentionally operated by detecting the stray light of the emitted laser by setting no dead time of the circuit. The dust mode and laser transponder mode were also confirmed to be normal. Besides, the quick look software of the LIDAR for monitoring the housekeeping data and data reduction has been developed, and the function was also confirmed in the initial checkout.

Future plan: The first chance of light detection will be realized as an experiment on the laser transponder mode before and after the Earth gravity assist in winter 2015. In this opportunity we can evaluate whether the alignment of the transmitting and receiving telescope keeps the required alignment position for ranging after the shock of the launch. The link budget of the laser can be also tested in this experiment.

After the Earth gravity assist operation, the spacecraft will be inserted into the transfer orbit, and it will arrive at the target asteroid in the middle of 2018 and the ranging with the LIDAR will start.

Keywords: LIDAR, Hayabusa-2, asteroid, laser altimeter, ranging, initial operation

PCG30-P05 Room:Convention Hall Time:May 26 18:15-19:30

Present status of curation of Hayabusa-returned samples

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The extraterrestrial sample curation team (ESCuTe) of JAXA has continued to perform initial description of Hayabusa-returned samples since 2010, when they had been returned to the Earth (Yada et al., 2014). A sample catcher of Hayabusa is mainly composed of room A and B, and a rotational cylinder. Since 2010 until 2013, we recovered particles from the room A and B of the catcher using synthetic quartz glass disks on which we let them fall down. On the contrast, the cover of room B is a part of the catcher which was disassemble from the catcher, so it should not suffer biases such as the fall-down process and the handpicking process. Since the end of 2013, we started describing all particles larger than 15 microns on a cover of room B of a catcher with an electron microscope, utilizing a specific holder newly developed for introducing the room B's cover directly into the electron microscope. So far, we finished to observe particles on 2/3 of area of the cover to count up more than 1800 of particles on it. Among them, those consist mainly of silicate and are considered to be Itokawa origin count up to more than 400.

Adding more than 100 of newly described particles among them to a list of distributable ones, we published the 3rd international announcement of opportunity (AO) for research of Hayabusa-returned samples in this January and are now waiting for research proposals until this March. Then committee of the 3rd AO will review submitted proposals and the selected proposals will be announced in this June. We will start distributing the allocated particles from this July.

We are now scheduling to finish describing particles on room B's cover in the first half of the fiscal year of 2015. In the second half of FY2015, we will recover particles from the rotational cylinder, from which particles has not been recovered yet.

Reference: Yada T. et al. (2014) Meteoritics Planet. Sci. 49, 135.

Keywords: asteroid, Itokawa, Hayabusa, curation, sample return, LL chondrite

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Statistical analyses of lineaments on Phobos: implications to their formational processes and orbital environment

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There are mainly two hypotheses on the origin of the martian satellites, Phobos and Deimos. One is that they are captured, because these spectra are similar to D-type asteroids in the outer main asteroid belt and outer solar system. The other is that they formed in situ from a disk of debris in Mars' orbit, because these are low inclination and near-circular orbits. In the former hypothesis, there is a difficulty accounting for these physical characters. Therefore in situ formational models have been studied in detail. One of the models for the origin of Phobos and Deimos is as follows. Primary many moonlets have formed by accretion of disk materials and orbited Mars. These moonlets fall back towards the martian surface by tidal perturbations, and finally only two moons, Phobos and Deimos, remain in present martian system [1].

Schmedemann et al. [2] estimated 4.3 Ga for the formation age of Phobos and Deimos by crater chronology. In numerical analyses, moonlets with Deimos' mass can accrete near the synchronous orbit. A Phobos' mass moonlet could also be formed in the same disk. This moonlet is however formed closer to Mars. Thus, it collides with Mars because of tidal decay of its orbit. Therefore Phobos' mass moonlet needs to be formed near to synchronous orbit [3]. The ancient distance from Mars is a clue to the origin of the martian satellites.

On the other hand, lineaments on Phobos are the most extensively-existing geological features on the satellite, and thus are documented and discussed for years [4]. From principal component analysis, we confirmed the important character that all the lineaments lie on planes. We suggest that these structures are certainly a result of a series of impacts of aligned fragments.

We simulate several trajectories that arrive at Phobos, changing the number and the size of fragments. We examine that a small body of a collection of smaller fragments held together by self-gravity in form of a rubble-pile is pulled apart and stretched straightly by tides during a close approach to Mars.

Then we test how the linearly-lined fragments change positions relatively by gravitational effect and how patterns leave on Phobos when the fragments arrive at Phobos.

Collectively, the placement of fragments patterns consistent with the observational facts. Furthermore we suppose that fragments form a ring, because lineaments' widths are almost same, and some lineaments appear to be parallel. In this model, we find Phobos needs to be to synchronous orbit when lineaments form.

Reference
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Keywords: Phobos, Lineaments

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MU radar head echo observations of the 2012 October Draconid outburst

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We present October Draconid meteor head echo observations with the Shigaraki middle and upper atmosphere (MU) radar in Japan. Prominent activity of 2012 October Draconids occurred between 16:20 UT and 17:40 UT on October 8. Around the peak time (13-20 h UT), the MU radar recorded 51 Draconid head echoes with precise orbit determinations. The weighted mean geocentric radiant during this time interval was α = 262.5 $\pm$ 0.5 in right ascension, δ = +55.8 $\pm$ 0.3 declination (degree, epoch J2000.0) with the weighted mean geocentric velocity of 20.6 $\pm$ 0.3 km s^{-1}, which are in good agreement with model predictions. Although the models predicted no strong visually detectable activity, our head echo observations showed that the peak activity in 2012 was higher than that of the previous outburst in 2011. Based on the distribution of radar cross section (RCS) for the Draconid meteor head echo, the outburst in 2012 was due to meteoroids with lower masses (fainter meteors) than that in 2011.

Keywords: meteor shower, radar observation, head echo

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Prediction of Phoenicid

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The Phoenicids appeared in 1956 is caused from the comet 289P/Blanpain.

The meteors has relative velocity 10km/s to the earth, the lowest among the known meteors, and the dust trail encounters to Jupiter very frequently. The Phoenicids would appear in 2014. So we made prediction of Phoenicids in two dimension.

The great apparition in 1956 was caused by the simultaneous encounter of many dusttrails ejected in 18-19 centuries. On the other hand, the apparition in 2014 will caused by non-simultaneous encouner of the dusttrails ejected in 19-20 centuries. So we assumed the apparition in 2014 would not be so many. The observation result was about HR5.

Phoenicids has 95-year periodicy. So the next apparition will be in 2015.

Keywords: Phoenicid, prediction