

[E] Oral | P (Space and Planetary Sciences) : P-PS Planetary Sciences

📅 Sun. Jun 6, 2021 3:30 PM - 5:00 PM JST | Sun. Jun 6, 2021 6:30 AM - 8:00 AM UTC | 📍 Ch.04 Zoom Room 04

[P-PS04] Small Solar System Bodies: A New Insight from Hayabusa2, OSIRIS-REx and Other Space Missions

convener: Tatsuaki Okada (Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency), Taishi Nakamoto (Tokyo Institute of Technology), Daisuke Kuroda (Kyoto University),
Chairperson: Tatsuaki Okada (Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency), Taishi Nakamoto (Tokyo Institute of Technology), YACHEN YANG (Center for Space and Remote Sensing Research)

Small Solar System bodies, including asteroids, comets, satellites, and interplanetary dust particles, are notably important for understanding the origin and evolution of our Solar System, as well as investigating the sources of building blocks of life. Many new discoveries on small bodies have been carried out by observations from ground-based and space-based observatories, and explorations by spacecraft rendezvous and flyby. New perspectives on solar system evolution have been paved by analyses of extraterrestrial materials such as meteorites, IDPs, and return samples by space missions. Numerical and laboratory simulation studies have helped interpretations for those results and proposed new insights on these topics. In this session, new results of scientific studies and new ideas of methodology for investigating small solar system bodies are highly welcome, especially the topics on the remote sensing, surface experiments, and analysis of return sample in the Hayabusa2 and OSIRIS-REx missions, as well as the expectations and preparations for future missions including MMX, Destiny+, Hera, Comet Interceptor, and Hayabusa2-Extended missions.

3:30 PM - 3:50 PM JST | 6:30 AM - 6:50 AM UTC

[PPS04-19] Impact histories inferred from exogenic boulders on asteroids Ryugu and Bennu

★Invited Papers

*ERI TATSUMI^{1,2}, Chiho Sugimoto², Seiji Sugita², Marcel Popescu⁴, Humberto Campins¹¹, Julia de León³, Amy A. Simon⁵, Hannah H. Kaplan⁶, Yuichiro Cho², Tomokatsu Morota², Rie Honda⁷, Shingo Kameda⁸, Yasuhiro Yokota³, Koki Yumoto², Minami Aoki², Daniella N. DellaGiustina¹⁰, Dathon R. Golish¹⁰, Javier Licandro¹, Juan Luis Rizo¹, Takahiro Hiroi¹², Deborah Domingue¹³, Michel Patrick¹⁴, Dante S. Loretta¹⁰, Manabu Yamada¹⁵, Naoya Sakatani⁸, Toru Kouyama⁹, Chikatoshi Honda¹⁶, Masahiko Hayakawa³, Moe Matsuoka³, Hidehiko Suzuki¹⁷, Kazunori Ogawa³, Hirotaka Sawada³ (1. Instituto de Astrofísica de Canarias, 2. Univ. of Tokyo, 3. ISAS/JAXA, 4. Astronomical Institute of the Romanian Academy, 5. NASA Goddard Space Flight Center, 6. Southwest Research Institute, 7. Kochi Univ., 8. Rikkyo Univ., 9. AIST, 10. Univ. of Arizona, 11. Univ. of Central Florida, 12. Brown Univ., 13. Planetary Science Institute, 14. Observatoire de la Côte d'Azur, 15. Chiba Institute of Tech., 16. Univ. of Aizu, 17. Meiji Uni.)

3:50 PM - 4:10 PM JST | 6:50 AM - 7:10 AM UTC

[PPS04-20] The ESA Hera mission: rendezvous with a binary asteroid, planetary defense and science

★Invited Papers

*Patrick Michel¹, Michael Kueppers², Alan Fitzsimmons³, Simon F. Green⁴, Monica Lazzarin⁵, Stephan Ulamec⁶, Ian Carnelli⁷, Paolo Martino⁷ (1. Université Côte D'Azur, Observatoire De La Côte D'Azur, CNRS, Laboratoire Lagrange, 2. ESA-European Space Astronomy Centre, 3. Queen's University Belfast, 4. The Open University, 5. Padova University, 6. DLR RB-MUSC, 7. ESA-ESTEC)

4:10 PM - 4:25 PM JST | 7:10 AM - 7:25 AM UTC

[PPS04-21] Hayabusa2 Extended Mission to rendezvous with Asteroid 1998 KY26:

Investigations of an extremely small fast rotator for planetary defense

*Masatoshi Hirabayashi¹, Y. Mimasu², N. Sakatani³, S. Watanabe⁴, Y. Tsuda², T. Saiki², S. Kikuchi², T. Kouyama⁵, M. Yoshikawa², S. Tanaka², S. Nakazawa², Y. Takei², F. Terui², H. Takeuchi², A. Fujii², T. Iwata², K. Tsumura⁶, S. Matsuura⁷, Y. Shimaki², S. Urakawa⁸, Y. Ishibashi⁹, S. Hasegawa², M. Ishiguro¹⁰, D. Kuroda¹¹, S. Okumura⁸, S. Sugita¹², T. Okada², S. Kameda³, S. Kamata¹³, A. Higuchi¹⁴, H. Senshu¹⁵, H.

Noda¹⁶, K. Matsumoto¹⁶, R. Suetsugu¹⁷, T. Hirai¹⁵, K. Kitazato¹⁸ (1.Auburn University, 2.Japan Aerospace Exploration Agency, 3.Rikkyo University, 4.Nagoya University, 5.National Institute of Advanced Industrial Science and Technology, 6.Tokyo City University, 7.Kwansei Gakuin University, 8.Japan Spaceguard Association, 9.Hosei University, 10.Seoul National University, 11.Kyoto University, 12.University of Tokyo, 13.Hokkaido University, 14.University of Occupational and Environmental Health, 15.Chiba Institute of Technology, 16.National Astronomical Observatory of Japan, 17.National Institute of Technology, 18.University of Aizu)

4:25 PM - 4:40 PM JST | 7:25 AM - 7:40 AM UTC

[PPS04-22] **Highly Time-Resolved Photometric Observations of Tiny Near Earth Objects with the Tomo-e Gozen Camera**

*Jin Beniyama¹, Shigeyuki Sako¹, Ryou Ohsawa¹, Satoshi Takita¹, Naoto Kobayashi¹, Shin-ichiro Okumura², Seitaro Urakawa², Fumihiko Usui³, Fumi Yoshida^{4,5}, Makoto Yoshikawa³ (1.Institute of Astronomy, Graduate School of Science, The University of Tokyo, 2.Japan Spaceguard Association, 3.Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 4.University of Occupational and Environmental Health, 5.Planetary Exploration Research Center, Chiba Institute of Technology)

4:40 PM - 4:55 PM JST | 7:40 AM - 7:55 AM UTC

[PPS04-23] Color and size distributions of main belt asteroids obtained by the Subaru/Hyper Suprime-Cam

*Natsuho Maeda¹, Tsuyoshi Terai², Keiji Ohtsuki¹, Fumi Yoshida^{3,4}, Kosuke Ishihara^{1,2,5}, Takuto Deyama^{1,6} (1.Graduate school of science, Kobe University, 2.National Astronomical Observatory of Japan, 3.Chiba Institute of Technology, 4.University of Occupational and Environmental Health, 5.The Graduate University for Advanced Studies, 6.NTT Data MSE Corporation)

4:55 PM - 5:00 PM JST | 7:55 AM - 8:00 AM UTC

[PPS04-24] Discussion

Impact histories inferred from exogenic boulders on asteroids Ryugu and Bennu

*ERI TATSUMI^{1,2}, Chiho Sugimoto², Seiji Sugita², Marcel Popescu⁴, Humberto Campins¹¹, Julia de León³, Amy A. Simon⁵, Hannah H. Kaplan⁶, Yuichiro Cho², Tomokatsu Morota², Rie Honda⁷, Shingo Kameda⁸, Yasuhiro Yokota³, Koki Yumoto², Minami Aoki², Daniella N. DellaGiustina¹⁰, Dathon R. Golish¹⁰, Javier Licandro¹, Juan Luis Rizos¹, Takahiro Hiroi¹², Deborah Domingue¹³, Michel Patrick¹⁴, Dante S. Laretta¹⁰, Manabu Yamada¹⁵, Naoya Sakatani⁸, Toru Kouyama⁹, Chikatoshi Honda¹⁶, Masahiko Hayakawa³, Moe Matsuoka³, Hidehiko Suzuki¹⁷, Kazunori Ogawa³, Hirotaka Sawada³

1. Instituto de Astrofísica de Canarias, 2. Univ. of Tokyo, 3. ISAS/JAXA, 4. Astronomical Institute of the Romanian Academy, 5. NASA Goddard Space Flight Center, 6. Southwest Research Institute, 7. Kochi Univ., 8. Rikkyo Univ., 9. AIST, 10. Univ. of Arizona, 11. Univ. of Central Florida, 12. Brown Univ., 13. Planetary Science Institute, 14. Observatoire de la Côte d'Azur, 15. Chiba Institute of Tech., 16. Univ. of Aizu, 17. Meiji Uni.

Rubble-pile asteroids, such as (162173) Ryugu and (101955) Bennu, are formed as a result of catastrophic disruption of a parent body and re-accumulation of the fragments by self-gravity (Michel and Ballouz et al. 2020). Therefore, reaccumulated rubble piles could include mixtures of materials from both the parent body and its catastrophic impactor, as they did in the case of 2008 TC₃ and the Almahata Sitta meteorites (Jenniskens et al. 2009). Indeed, six unusually bright, basaltic, meter-scale boulders were recently identified on Bennu's dark surface (DellaGiustina et al. 2021), and their close spectral matches to the Howardite-Eucrite-Diogenite (HED) meteorites and Vesta family members indicate that they originated from asteroid (4) Vesta. In parallel, bright exogenic anhydrous-silicate-rich materials were found on Ryugu (Tatsumi et al. 2021). The bright boulders on Ryugu are consistent with ordinary chondrite meteorites, based on their albedo and the weak or even absent absorption band at 2 μm. These exogenous materials on the surfaces of rubble-pile asteroids could be a key to constraining their specific impact conditions and collisional evolution.

In this study, we report further study of the visible spectrophotometry and morphology of exogenic boulders on Ryugu and Bennu using two multi-band cameras: the telescopic Optical Navigation Camera (ONC-T) onboard the Hayabusa2 spacecraft, and MapCam onboard the Origins, Spectral Interpretation, Resource Identification, and Security-Regolith Explorer (OSIRIS-REx) spacecraft, respectively.

For Ryugu, we first detected objects with peak reflectance brighter by a factor of >1.5 than the surrounding area. Tatsumi et al. (2021) found two spectral groups among the bright boulders: S-type with an absorption near 1 μm and C/X-type with a flat spectrum. That study found 6 S-types and 15 C/X-types, and here we report the additional finding of two S-types and ~70 C/X-types. We found that S-type bright boulders follow two parallel trends consistent with space weathering of ordinary chondrites. Fragments from projectiles suggest that Ryugu may not have formed directly from the original parent body, i.e., it is from a second or higher generation of collisional descendants (Sugimoto et al. in revision).

For Bennu, we directly surveyed the absorption near 1 μm, which is indicative of anhydrous silicates. We propose 77 objects of exogenic origin including 6 boulders previously reported by DellaGiustina et al. (2021). We find that proposed exogenic objects follow two mixing trends with respect to the average spectrum of Bennu (Tatsumi and Popescu et al. submitted). One trend can be explained by mixing with HEDs, as discussed in DellaGiustina et al. (2021), and the other trend can be explained by mixing with

another, of olivine-rich composition. Near-infrared spectra also support the possibility of multiple compositions among exogenic objects on Bennu. Le Corre et al. (submitted) also reached to the similar conclusion with a different methodology. Thus, similar to Ryugu, Bennu could represent a second or higher generation collisional fragment.

Using high-resolution images, we found that more than half of the exogenic objects that we identified on Bennu have breccia-like or inclusion-like morphologies. We do not observe a correlation between morphology and spectral shape.

Direct comparison of reflectance spectra of exogenic materials between Ryugu and Bennu suggests a compositional difference. Furthermore, the number density of exogenic objects > 0.5 m on Bennu is ~ 40 times that on Ryugu (Tatsumi and Popescu et al. submitted). Bennu exhibits much more contamination from exogenic materials than Ryugu, which likely reflects differences in impact conditions, such as impact velocity and impactor size.

Michel and Ballouz et al. (2020) Nat. Commun. 11, 2655

Jenniskins et al. (2009) Nature 458, 485-488.

DellaGiustina et al. (2021) Nat. Astron. 5, 31-38.

Tatsumi et al. (2021) Nat. Astron. 5, 39-45.

Sugimoto et al. (in revision) Icarus.

Tatsumi and Popescu et al. (submitted) MNRAS.

Le Corre et al. (submitted) PSJ.

Keywords: Asteroids, Hayabusa2, OSIRIS-REx, Ryugu, Bennu

The ESA Hera mission: rendezvous with a binary asteroid, planetary defense and science

*Patrick Michel¹, Michael Kueppers², Alan Fitzsimmons³, Simon F. Green⁴, Monica Lazzarin⁵, Stephan Ulamec⁶, Ian Carnelli⁷, Paolo Martino⁷

1. Université Côte D'Azur, Observatoire De La Côte D'Azur, CNRS, Laboratoire Lagrange, 2. ESA-European Space Astronomy Centre, 3. Queen's University Belfast, 4. The Open University, 5. Padova University, 6. DLR RB-MUSC, 7. ESA-ESTEC

The Hera mission is in Phase C for launch in 2024 in the ESA Space Safety Programme. Hera will contribute to the first deflection test of an asteroid, in the framework of the international Asteroid Impact and Deflection Assessment (AIDA) collaboration, supported by NASA and ESA

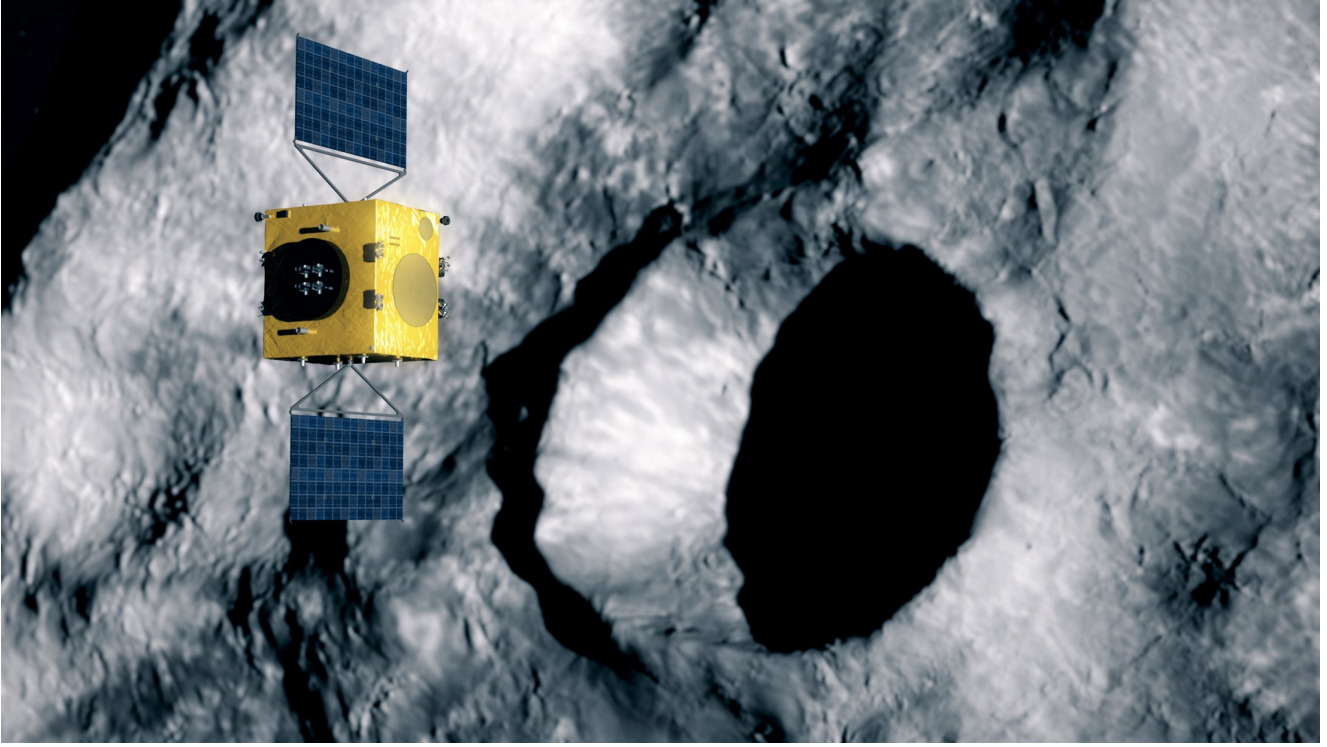
Hera will rendezvous for the first time with a binary asteroid, (65803) Didymos, and take particular emphasis on its secondary, Dimorphos, of only 160 m in diameter. So far, no mission has visited such a small rock in space. Moreover, for the first time, internal and subsurface properties will be directly measured. As a crucial contribution to planetary defense, Hera will perform the measurements necessary to understand the effect of the NASA DART impact on Didymos' secondary in 2022, in particular its mass, its internal structure, the direct determination of the momentum transfer and the detailed characterization of the crater left by DART.

How do binaries form? What does a 160 m-size rock in space look like? What is the surface composition? What are its internal properties? What are the surface structure and regolith mobility on both Didymos and Dimorphos? What are the surface geophysical properties of two objects of different size and surface gravity, which probably formed from the same material? And what will be the size and the morphology of the crater left by DART, which will provide the first impact experiment at full asteroid scale using an impact speed close to the average speed between asteroids? What will be the exact momentum transferred by DART, which needs the precise measurement of the mass of the target by Hera? These questions and many others will be addressed by Hera as a natural outcome of its investigations focused on planetary defense.

The measurements performed by Hera will thus provide unique information on many current issues in asteroid science and therefore, the scientific legacy of the Hera mission will extend far beyond the core aims of planetary defense. Hera is, thus, the main European contribution to the current international asteroid exploration era.

Acknowledgement: Funding support from ESA and from the European Union's Horizon 2020 research and innovation programme under grant agreement No 870377 (project NEO-MAPP) is acknowledged.

Keywords: Asteroids, Binary Asteroids, Impact Physics, Planetary defense, Cubesat, Space mission



Hayabusa2 Extended Mission to rendezvous with Asteroid 1998 KY26: Investigations of an extremely small fast rotator for planetary defense

*Masatoshi Hirabayashi¹, Y. Mimasu², N. Sakatani³, S. Watanabe⁴, Y. Tsuda², T. Saiki², S. Kikuchi², T. Kouyama⁵, M. Yoshikawa², S. Tanaka², S. Nakazawa², Y. Takei², F. Terui², H. Takeuchi², A. Fujii², T. Iwata², K. Tsumura⁶, S. Matsuura⁷, Y. Shimaki², S. Urakawa⁸, Y. Ishibashi⁹, S. Hasegawa², M. Ishiguro¹⁰, D. Kuroda¹¹, S. Okumura⁸, S. Sugita¹², T. Okada², S. Kameda³, S. Kamata¹³, A. Higuchi¹⁴, H. Senshu¹⁵, H. Noda¹⁶, K. Matsumoto¹⁶, R. Suetsugu¹⁷, T. Hirai¹⁵, K. Kitazato¹⁸

1. Auburn University, 2. Japan Aerospace Exploration Agency, 3. Rikkyo University, 4. Nagoya University, 5. National Institute of Advanced Industrial Science and Technology, 6. Tokyo City University, 7. Kwansei Gakuin University, 8. Japan Spaceguard Association, 9. Hosei University, 10. Seoul National University, 11. Kyoto University, 12. University of Tokyo, 13. Hokkaido University, 14. University of Occupational and Environmental Health, 15. Chiba Institute of Technology, 16. National Astronomical Observatory of Japan, 17. National Institute of Technology, 18. University of Aizu

Hayabusa2, led by the Japan Aerospace Exploration Agency (JAXA), brought material samples from asteroid Ryugu back to Earth. On December 6, 2020, the Hayabusa2 team successfully collected the re-entry capsule, while the spacecraft departed from Earth, again. As of January 2021, the spacecraft is reported to have no critical issues.

Based on the spacecraft's healthy condition and remaining fuel, the Hayabusa2 extended mission development team has evaluated the feasibility of an additional mission. Here, we introduce an extended mission in which the spacecraft will explore Asteroid 1998 KY26, a ~30 m - ~40 m in diameter asteroid rotating at a spin period of ~10 m, after a ~10-year cruise phase. Rendezvous operations are planned to detail the physical properties and surrounding environments of this target, one of the smallest elements of small planetary bodies.

In the planned mission schedule, the spacecraft will rendezvous with 1998 KY26 in late 2031. During this cruise phase, the spacecraft may fly by 2001 CC21 in middle 2026. It will approach the asteroid at high speed (~5 km/sec) during the flyby, and thus sophisticated guidance, navigation, and control technologies will be necessary. We also plan to conduct long-term monitoring of the zodiacal light and the transits of exoplanets. After two Earth swing-by operations in late 2027 and early 2028, the spacecraft will arrive at the target asteroid. The planned trajectory will need an additional delta-V of 1.09 km/sec, given the 2,900-sec Isp. The distance from the sun is ~1 AU when the spacecraft arrives at this asteroid.

There are key challenges that need to be resolved in Planetary Defense.

Extremely small bodies (especially smaller than 100 m in diameter) are the most common in the solar system and may have a high probability to influence our societies. Ground- and space-based-telescopes still have technical difficulties in observing these asteroids. Therefore, the physical properties of these objects are poorly understood. Successful planetary defense strategies strongly depend on the physical conditions of asteroids. Extremely small asteroids, which may be the largest pieces within rubble pile asteroid elements, will strongly constrain these conditions.

Given the planned observations, the Hayabusa2 extended mission will significantly contribute to advancing science and engineering knowledge about Planetary Defense by exploring an extremely small body.

Finally, we note that the Hayabusa2 extended mission was approved by the science-engineering space exploration mission assessment committee in Japan, which evaluated the scientific and engineering significance of the mission, and is currently waiting for official approval by the government for budgeting. Also, this abstract is also presented at the Planetary Defense Conference in 2021.

Keywords: Asteroids, Planetary defense, Space exploration mission

Highly Time-Resolved Photometric Observations of Tiny Near Earth Objects with the Tomo-e Gozen Camera

*Jin Beniyama¹, Shigeyuki Sako¹, Ryou Ohsawa¹, Satoshi Takita¹, Naoto Kobayashi¹, Shin-ichiro Okumura², Seitaro Urakawa², Fumihiko Usui³, Fumi Yoshida^{4,5}, Makoto Yoshikawa³

1. Institute of Astronomy, Graduate School of Science, The University of Tokyo, 2. Japan Spaceguard Association, 3. Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency, 4. University of Occupational and Environmental Health, 5. Planetary Exploration Research Center, Chiba Institute of Technology

Near Earth Objects (NEO) are solar system bodies whose perihelion distances are smaller than 1.3 au. NEOs are thought to have their origin in the main-belt region between Mars and Jupiter. In addition to the gravitational interaction with the Sun and planets, nongravitational effect which arise from solar radiation plays an important role in their dynamical evolution. YORP effect is one of the nongravitational effects that affects the spin state of an asteroid. YORP effect strongly changes the rotation periods of tiny asteroids (smaller than 100 m in diameter) on a shorter timescale than that of the orbital evolution. Fast rotators suffer from strong centrifugal force and may experience deformation or rotational fission when its rotation period reaches the critical value by YORP spin-up. Therefore the strength of tiny bodies could be inferred using rotation periods of tiny NEOs. Recently, large survey projects have discovered 2,000–3,000 NEOs per year and some fast rotators with rotation periods below a minute have been discovered. Highly time-resolved observations are needed to accurately detect fast rotation because the lower-limit of rotation period which can be detected depends on the overhead time of the instrument. Since the past instruments did not have enough time-resolution, the distribution of rotation periods of NEOs with periods below a minute is still unclear.

We obtained highly time-resolved light curves of 37 tiny NEOs whose diameters are 3–86 m using Tomo-e Gozen camera equipped with 105 cm Schmidt telescope at Kiso Observatory, the University of Tokyo. The observation cadence was 2 fps. We derived the rotation periods of 22 NEOs, of which 5 NEOs show the rotation periods shorter than 20 seconds. The shortest rotation period of our NEOs was about 11 seconds. In spite of high-cadence observations, we found no asteroid rotating shorter than 10 seconds. The lack of tiny fast rotating NEOs has never been reported before our systematic highly time-resolved observation. We discuss the diameter-rotation period relation derived from our observation in terms of YORP spin-up. The observed rotation period distribution is consistent with the scenario that the strength of tiny NEOs are weaker than those of meteorites. We also discuss another possible scenario that most tiny NEOs are newly-formed in the near-earth region instead of the main-belt.

Keywords: asteroid, near earth objects, solar system, light curve, YORP effect

Color and size distributions of main belt asteroids obtained by the Subaru/Hyper Suprime-Cam

*Natsuho Maeda¹, Tsuyoshi Terai², Keiji Ohtsuki¹, Fumi Yoshida^{3,4}, Kosuke Ishihara^{1,2,5}, Takuto Deyama^{1,6}

1. Graduate school of science, Kobe University, 2. National Astronomical Observatory of Japan, 3. Chiba Institute of Technology, 4. University of Occupational and Environmental Health, 5. The Graduate University for Advanced Studies, 6. NTT Data MSE Corporation

S-type and C-type asteroids are two of the most major types in the main asteroid belt (e.g., DeMeo & Carry 2014). S-type asteroids are thought to have a stony composition, while C-type asteroids are characterized by carbonaceous composition and hydrous minerals (e.g., DeMeo et al. 2015; Usui et al. 2019). Although S-type asteroids and C-type asteroids are thought to have different compositions and origins in this way, their evolution paths are still not well understood.

The size distribution of a population of asteroids strongly reflects the process of their collisional evolution (e.g., Bottke et al. 2015). In the collision equilibrium, the size distribution is primarily determined by the size dependence of impact strength (O'Brien & Greenberg 2003). Therefore, by comparing size distributions of asteroids with different spectral types, we can obtain information about the relation between their type and their impact strength. This is essential information to reveal their collisional evolution. Although some previous observational works studied size distributions of asteroids with different spectral types (Ivezić et al. 2001; Yoshida & Nakamura 2007), the understanding is still far from complete.

In this work, we performed a survey observation of small main-belt asteroids with the wide-field camera, Hyper Suprime-Cam installed on the 8.2 m Subaru Telescope. Using data acquired with two types of filters, *g*-band (0.40-0.55 μm wavelength) and *r*-band (0.55-0.70 μm wavelength), we measured *g-r* color for 3459 main-belt asteroids detected in 14 deg² of the sky. From the asteroids we obtained above, we selected a statistical sample consisting of 1814 asteroids with absolute magnitude brighter than 20.3 mag to remove a detection bias. We classified them into two groups, i.e., reddish "S-like" asteroids and bluish "C-like" asteroids based on the boundary color derived from the previous survey data (The fourth release of Sloan Digital Sky Survey Moving Object Catalog, Ivezić et al. 2010). We converted the absolute magnitude of each sample into a diameter assuming an albedo of 0.21 for S-like and 0.07 for C-like asteroids, respectively, which are the mean values of the S- and C-type main-belt asteroids measured by the infrared astronomical satellite AKARI (Usui et al. 2013). We found that the shapes of the size distributions of the S-like and C-like samples agree well with each other within statistical errors for the diameter range from 0.4 km to 1.5 km. The similarity between the size distributions of the S-like and C-like asteroids indicates that their size dependences of impact strength are also similar at least in the size range from several hundred meters to several kilometers. Namely, the impact strength of asteroids in this size range is likely to be dominated by any other factors rather than their compositions. On the other hand, spin periods of most asteroids in this size range have an upper limit of 2.2 hours, the so-called "spin-barrier" (e.g., Chang et al. 2015). This is interpreted as showing that the asteroids in this size range are rubble-piles, i.e., they consist of numerous pieces of components held together by their self-gravity. The similarity of the size distributions between the S-like and C-like asteroids seems to support the view that most of them have a rubble-pile structure. Also, Itokawa and Ryugu, which were explored by Hayabusa/Hayabusa2, are both several hundred meters in diameter and are considered to

have a rubble-pile structure (Fujiwara et al. 2006; Watanabe et al. 2019). Our result is also consistent with this view.

Keywords: asteroids, survey, size distributions

[E] Oral | P (Space and Planetary Sciences) | P-PS Planetary Sciences

[P-PS04] Small Solar System Bodies: A New Insight from Hayabusa2, OSIRIS-REx and Other Space Missions

convener:Tatsuaki Okada(Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency), Taishi Nakamoto(Tokyo Institute of Technology), Daisuke Kuroda(Kyoto University),

Chairperson:Tatsuaki Okada(Institute of Space and Astronautical Science, Japan Aerospace Exploration Agency), Taishi Nakamoto(Tokyo Institute of Technology), YACHEN YANG(Center for Space and Remote Sensing Research)

Sun. Jun 6, 2021 3:30 PM - 5:00 PM Ch.04 (Zoom Room 04)

Small Solar System bodies, including asteroids, comets, satellites, and interplanetary dust particles, are notably important for understanding the origin and evolution of our Solar System, as well as investigating the sources of building blocks of life. Many new discoveries on small bodies have been carried out by observations from ground-based and space-based observatories, and explorations by spacecraft rendezvous and flyby. New perspectives on solar system evolution have been paved by analyses of extraterrestrial materials such as meteorites, IDPs, and return samples by space missions. Numerical and laboratory simulation studies have helped interpretations for those results and proposed new insights on these topics. In this session, new results of scientific studies and new ideas of methodology for investigating small solar system bodies are highly welcome, especially the topics on the remote sensing, surface experiments, and analysis of return sample in the Hayabusa2 and OSIRIS-REx missions, as well as the expectations and preparations for future missions including MMX, Destiny+, Hera, Comet Interceptor, and Hayabusa2-Extended missions.

4:55 PM - 5:00 PM

[PPS04-24]Discussion