EPSC Abstracts
Vol. 13, EPSC-DPS2019-631-1, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

Characteristics of dark and bright areas on the asteroid Ryugu

E. Palomba (1,2), A. Galiano (1), M. D'Amore (3), A. Zinzi (2), F. Dirri (1), A. Longobardo (1), K. Kitazato (4), T. Iwata (5), M. Matsuoka (5), T. Hiroi (6), D. Takir (7), T. Nakamura (8), M. Abe (5), M. Ohtake (5), S. Matsuura (9), S. Watanabe (10), M. Yoshikawa (5), T. Saiki (5), S. Tanaka (5), T. Okada (5), Y. Yamamoto (5), Y. Takei (5), K. Shirai (5), N. Hirata (11), N. Hirata (4), K. Matsumoto (12), Y. Tsuda (5).

(1) INAF-IAPS, Rome, Italy (anna.galiano@inaf.it), (2) SSDC-ASI, Rome, Italy, (3) German Aerospace Center, Institute of Planetary Research, Berlin, Germany, (4) University of Aizu, Aizu-Wakamatsu 965-8580, Fukushima, Japan, (5) Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency, Sagamihara, 252-5210, Japan, (6) Department of Earth, Environmental and Planetary Sciences, Brown University, Providence, RI 02912, USA, (7) Jacobs/NASA Johnson Space Center, USA, (8) Tohoku University, Miyagi, Japan., (9) Kwansei Gakuin University, Hyogo, Japan, (10) Nagoya University, Nagoya 464-8601, (11) Kobe University, Kobe 657-8501, Japan, (12) National Astronomical Observatory of Japan, Mitaka 181-8588, Japan,

Abstract

The Japanese Hayabusa2 space mission approached the Near-Earth asteroid 162173 Ryugu in June 2018. Since then, it is taking data and mapping in detail the asteroid surface, finding a very dark and boulder rich asteroid with very homogenous spectral reflectance properties in the near IR. By using the data obtained by the NIRS 3 spectrometer, the intent of this work is to detect dark and bright patches and to study their characteristics, with the support of statistical and machine learning tools.

1. Introduction

The 27th of June 2018 the Japanese Haybusa2 spacecraft approached the C-type near earth asteroid 162173 Ryugu [1].
Haybusa2 is equipped with three remote sensing instruments such as the Thermal Infrared Imager TIR [2], the NIRS 3 spectrometer [3] and the Optical Navigation Camera-Telescopic (ONC-T) with a wideband and seven narrow band filters [4]. A Lidar instrument [5] allowed to reconstruct the shape model of the asteroid and to measure the altimetry, to perform a precise touchdown in sampling the asteroidal regolith. Additionally, by using the robotic landers Minerva-II and Mascot [6], Hayabusa 2 has been conducted in situ surface experiments.
Ryugu is a top-shaped Cb type asteroid and is covered by a large number of boulders [7,8]. It is one of the darkest object in our Solar System with a quite homogenous composition, including OH-rich materials [7,9].

2. Bright and Dark areas on Ryugu

Despite the high degree of homogeneity of the surface, our intent is to detect bright and dark areas by using the NIRS 3 spectrometer data in the spectral range 1.8-3.1 μm. An approach similar to that were used for Vesta and Ceres [10,11] have been applied. This methodology allowed to obtain for each pixel the reflectance factor at 2.5 μm. We adopted a relative definition both for bright and dark areas. First, we estimated the mean reflectance value of Ryugu surface relative to the wavelength of 2.5 μm, that is 0.0187. Then, we defined as a bright area all those regions characterized by a reflectance value larger than the 7% than the Ryugu mean reflectance. Similarly, the dark areas are defined as the regions with a reflectance value that is lower than the 8% than the Ryugu mean reflectance and lager than 0.01 (to avoid false positives due to the low S/N).

To create a dark and bright catalogue we used calibrated and thermally corrected NIRS 3 data taken on the 10, 11 and 19 July 2018, when the spacecraft was located at an altitude of 20 km (Home Position) and 13 km and with a spatial resolution of 40 m and 20 m, respectively.

3. Results

We found 20 bright areas and 30 dark areas on the surface of Ryugu. Dark areas are mainly located in

the middle latitudes with few of them towards the poles. They are completely absent in the equatorial regions, specifically between +25° and -25°. Bright areas have the reverse behaviour being mainly located in the equatorial latitudes: 75% of bright areas are located within (+30° -30°), whereas only few of them (25%) are towards the polar regions. The spectral characteristics of both the area types are similar to the general Ryugu behaviors as shown in Fig.2. However, if we normalize the average bright and dark spectra to the average Ryugu, we can enhance differences among the different families. This is particularly evident in Fig. 2. In summary, we observe tree main spectral behaviors on the Ryugu surface regions:

- As expected dark areas have lower reflectances as bright areas have higher relfectances
- Dark areas are typically redder than average Ryugu
- Bright areas are typically more “hydrated than average Ryugu

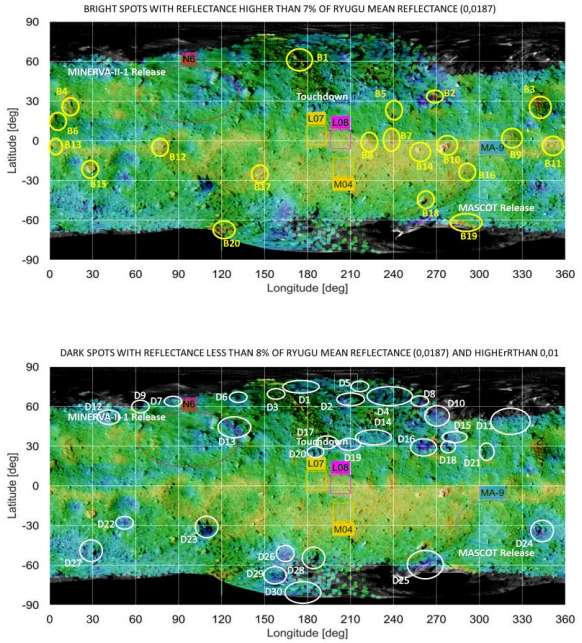

Figure 1. Distribution of bright and dark areas on the Ryugu surface superposed onto the reflectance map at 2.5µm. Bright and dark areas are represented by yellow (upper map) and white ellipses (lower map), respectively.

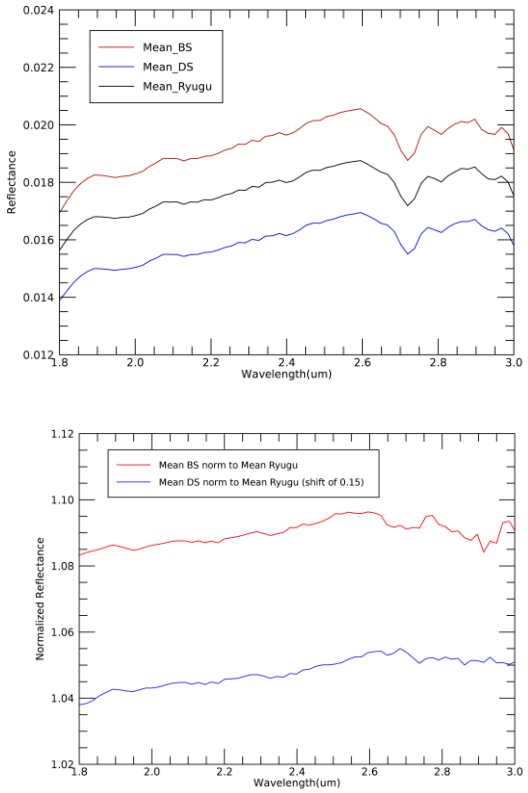

Figure 2. (Top): Ryugu Average spectra (red-bright average; dark-Ryugu average; blue-dark average). (Bottom): Bright average normalized to the Ryugu average (red), dark average normalized to the Ryugu average (blue)

References

[1] Watanabe S. et al. (2017) Space Sci. Rev. , 208, 3–16
[2] Okada T. et al. (2017) Space Sci. Rev., 208, 255-286
[3] Iwata T. et al. (2017) Space Sci. Rev., 208, 317–337 (2017)
[4] Kameda S. et al. (2016) Space Sci. Rev., 208, 17–31
[5] Mizuno T. et al. (2016) Space Sci. Rev., 208, 33–47
[6] Ho T.M. et al. (2017) Space Sci. Rev., 208, 255-286
[7] Sugita et al., (2019) Science, 364, eaaw0422
[8] Watanabe S. et al. (2019) Science, 364, 268-272
[9] Kitazato, K. et al., (2019) Science, 364, 272-275
[10] Palomba et al., (2014), Icarus 240, 58-72
[11] Palomba et al., (2019), Icarus 320, 2019, 202-212