NORMAL ALBEDO MAP OF RYUGU AT VISIBLE WAVELENGTH. Y. Yokota[1,2], R. Honda[2], E. Tatsumi[3,4,5], D. Domingue[6], S. E. Schröder[7], M. Matsuoka[1], S. Sugita[5], T. Morota[5,8], N. Sakatani[1], S. Kameda[9], T. Kouyama[10], H. Suzuki[11], M. Yamada[12], C. Honda[13], M. Hayakawa[1], K. Yoshioka[5], Y. Cho[5], and H. Sawada[1], [1]ISAS/JAXA, (3-1-1 Yoshino-dai, Chuo-ku, Sagamihara, Kanagawa, Japan, yokota@planeta.sci.isas.jaxa.jp). [2]Kochi Univ., Japan, [3]Instituto de Astrofisica de Canarias, Spain, [4]Univ. of La Laguna, Spain, [5]Univ. of Tokyo, Japan, [6]Planetary Science Institute, USA, [7]DLR, Germany, [8]Nagoya Univ., Japan. [9]Rikkyo Univ., Japan. [10]AIST, Japan, [11]Meiji Univ., Japan, [12]Chiba Inst. Tech, Japan, [13]Univ. of Aizu, Japan.

Introduction: Since June 2018, the Optical Navigation Camera (ONC) onboard Hayabusa2 has observed Ryugu at a distance below 20 km [1]. ONC consists of three cameras: ONC-T, -W1 and -W2, [2–4]. ONC-T has 7 broadband filters ranging in wavelength from 0.40–0.95 μm [2]. We report on the derivation of the normal albedo map of Ryugu from the opposition observations by the ONC-T.

Data: On 8 January 2019, Hayabusa2 moved to the sub-solar position, and ONC-T observed the asteroid at the opposition geometry from ~20 km distance, during one rotation period. A 7-band image set was obtained every 30° rotation phase. Local solar phase angle ranged from 0.0° to ~1.7°. Therefore, if we have a phase curve for this narrow phase angle range, we can convert each pixel's observed *I/F* (radiance factor) to the ideal *I/F* at phase angle zero, which is the normal albedo [5].

Method: The data number of the image pixels are converted to *I/F* with the calibration parameters described in [4]. Observation geometry of each pixel is calculated using the Ryugu shape model [6] produced by the Hayabusa2 shape model team.

Fitting. To average the data density bias in the geometry space, the data was binned every 1° in incidence and emission angle, and every 0.1° in phase angle. To avoid the effect of the solar disk size, data within the phase angle range 0.0–0.25° were omitted from the data set. Then, we fit a linear formula to the data set as

$$r = a_0 + a_1 \alpha \, , \tag{1}$$

where r is *I/F*, and a_0 and a_1 are fitting parameters. Fig. 1 shows the data set and the fitted line. The derived parameters are a_0 =0.0404 and a_1= -0.0019. Therefore, we estimate the average normal albedo of Ryugu is ~0.0404.

Mapping. We assume that this phase curve shape (a straight line for this case) is approximately the same for phase angles <1.7° for all Ryugu's surface and all ONC-T bands. Then, the observed *I/F* at near opposition can be converted to the *I/F* at phase angle zero, by

$$r(0) = r_{\mathrm{obs.}}(\alpha) \frac{a_0}{a_0 + a_1 \alpha} , \tag{2}$$

where $r(0)$ is normal albedo, and $r_{\mathrm{obs.}}(\alpha)$ is the observed *I/F* at phase angle α. This equation does not contain corrections for incidence angle i and emission angle e. After the conversion to $r(0)$, we checked the remaining dependency on i and e. Since we found that the remaining dependency is very small (< ~1% of the brightness) over this phase angle range, we did not add a correction for i and e.

Finally, we projected the $r(0)$ values over the complete rotation set of images to create a mosaic map for each band.

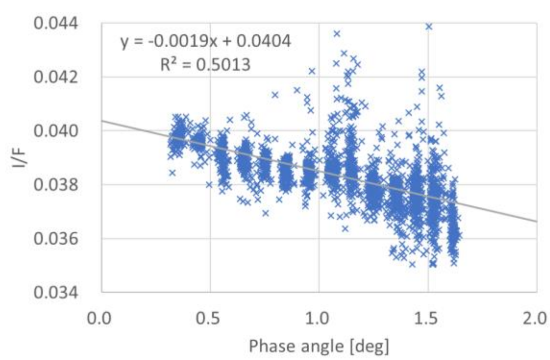

Fig. 1. Phase curve data set at near opposition. Grey line is a fitted line.

Results and discussion: Fig. 2 shows the v-band normal albedo map in simple cylindrical projection. Since the observed brightness at the opposition condition is less affected by shadows or topographic undulation than other geometry, the derived map successfully shows albedo distribution under minimal noise conditions.

The color study [e.g. 1, 7, 8] of Ryugu reported that the general spectral slope from b-band (0.48 μm) to x-band (0.86 μm) exhibits the greatest regional variation on Ryugu. Currently, we found that the normal albedo is well correlated with the b-x spectral slope. Fig. 3 shows a clear correlation between the b-band normal albedo and b/x ratio (simple substitution of the spectral slope), suggesting bluer is brighter. However, further study is necessary to interpret this relationship.

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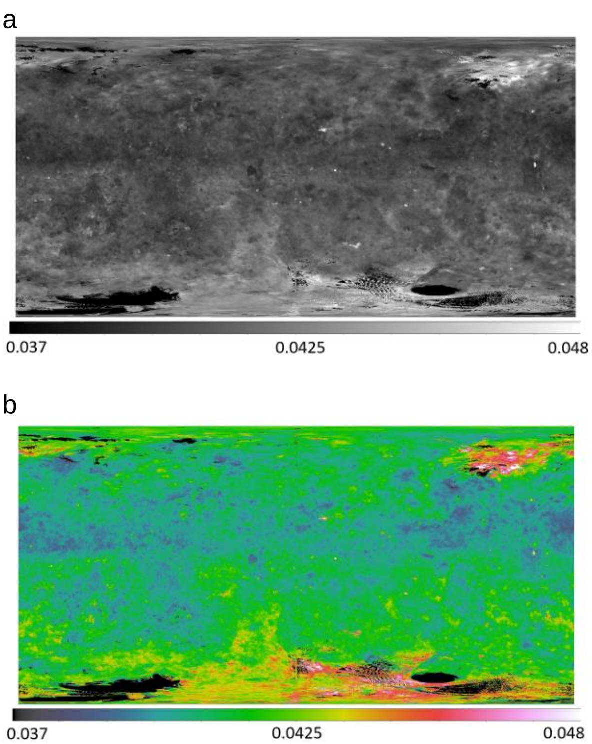

Fig. 2. Normal albedo (I/F at phase angle zero) map of Ryugu at v-band (0.55 μm). (a) Grey scale. (b) Color scale.

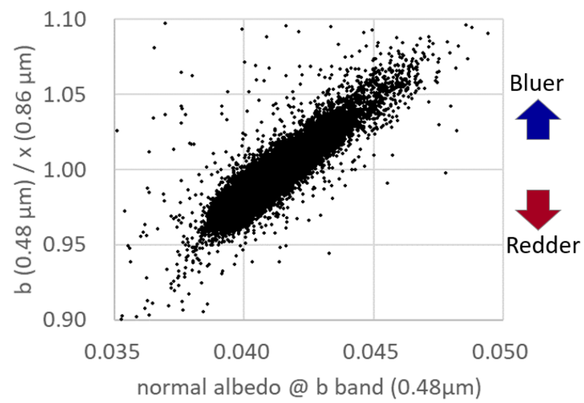

Fig. 3. Normal albedo ratio of b-band (0.48 μm) / x-band (0.86 μm) is shown as a function of b-band normal albedo. Global data of ~8x8 m (1 deg at equator) size bin is plotted.