Visible Wavelength Normal Albedo Map of Ryugu Derived by Hayabusa2 Optical Navigation Camera

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Asteroid explorer Hayabusa2 observed Cb-type asteroid 162173 Ryugu between June 2018 and November 2019 at a distance below 20km. The Telescopic Optical Navigation Camera (ONC-T) [1–4] onboard Hayabusa2 observed Ryugu with 7 broadband filters ranging in wavelength from 0.40–0.95 μm. On 8 January 2019, ONC-T observed the asteroid in the opposition geometry from ~20 km distance, through one rotation period (7.6 hr) in 7-band. The local solar phase angle of each pixel ranges from 0.0° to ~1.7°. This data set is well suited to derive the normal albedo, defined as the radiance factor (I/F) at phase angle 0° [5]. We present the normal albedo map from this observation.

The data number of the raw image pixels are converted [4] to I/F. The observation geometry of each pixel is calculated using the Ryugu shape model [6] produced by the Hayabusa2 shape model team. We fit a linear function to the phase function plot within the phase angle range 0.2–1.7°. Using this phase function, each pixel's I/F was extrapolated to normal albedo. Finally, we create a mosaic map of normal albedo for each band.

Since the observed brightness at the opposition condition is less affected by shadows or topographic undulation than other geometries, the derived map successfully shows the albedo distribution under minimal noise conditions. The color study [e.g. 1, 6, 7, 8] of Ryugu reported that the spectral slope from b-band (0.48 μm) to x-band (0.86 μm) exhibits the greatest regional variation on Ryugu. We found that the normal albedo is well correlated with the b-x spectral slope. Further study is necessary to interpret this relationship.

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References: [1] Sugita S. et al. (2019) Science 10.1126/science.aaw0422. [2] Kameda S. et al. (2017) SSR 208, 17–31. [3] Suzuki H. et al. (2018) Icarus 300, 341–359. [4] Tatsumi E. et al. (2019) Icarus 325, 153–195. [5] Li J.-Y., et al. (2015) Asteroids IV, University of Arizona Press, 129–150. [6] Watanabe S. et al. (2019) Science 364, 268-272. [7] Morota T. et al. (2020) (submitted). [8] Tatsumi E. et al. (2020) (in preparation).

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