Global Thermal Inertia and Surface Roughness of Asteroid 162173 Ryugu by TIR on Hayabusa2

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Thermal infrared imager TIR onboard the Hayabusa2 spacecraft acquired thermal images of the asteroid 162173 Ryugu for one asteroid rotation during Mid-altitude operation on August 1, 2018, with around 5 m/pixel resolution. The thermal images were converted to brightness temperature maps on a shape model based on the ground tests, then temperature profiles of the surface of Ryugu were obtained. For comparison, thermal calculations by a thermophysical model without roughness using the shape model (TPM1) and by one with roughness using fractal rough surfaces (TPM2) were carried out.

Thermal images by TIR reveled that the surface of Ryugu showed ubiquitously high temperature above 300 K, and its temperature profile showed flat pattern at noon. Thermal calculations by TPM1 did not reproduce observed temperature profiles. By comparing maximum temperatures by TIR with those by TPM1, thermal inertia of Ryugu was estimated to be around 160 in MKS unit and reached maximum at the equatorial ridge. By contrast, thermal calculations by TPM2 successfully created flat temperature profile at noon for various thermal inertia and surface roughness. The temperature profiles were fitted by 4-order function to characterize its pattern. A multi linear regression analysis was carried out to estimate thermal inertia and surface roughness from the fitting coefficients. From the regression equations and fitting coefficients by observed temperature profiles, thermal inertia and surface roughness of Ryugu were estimated. Since the estimation is strongly affected by surface tilt angle of a polygon on a shape model, we carried out tilt angle corrections. Finally, thermal inertia of Ryugu by TPM2 was estimated to be around 330 in MKS unit and showed little variation in latitude, and with moderate homogeneous surface roughness. Thermal inertia of Ryugu determined in this study by two TPMs are consistent with that determined by ground observations. Our results suggest that thermal inertia of Ryugu is consistent with that of boulders, indicating porous nature of the boulders widely distributed on Ryugu.

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