

論文内容の要旨

論文題目 Spectral Investigations of Surface Heterogeneity and Space-Weathering Processes on Asteroid Itokawa

(小惑星イトカワの表面不均質性と宇宙風化過程における分光学的研究)

氏名 北里 宏平

The Japanese Hayabusa spacecraft made a successful close-up exploration of the S-type asteroid 25143 Itokawa in three-month from early September 2005. The preliminary analyses have revealed a rubble pile structure for this sub-kilometer sized small asteroid, in contrast to the other large S-types so far spacecraft visited, from the bulk density, inferred composition, and evidence for global geomorphologic features. Additionally, Hayabusa imaged the asteroid surface piled up with numerous angular boulders, not covered with fine regoliths formed by impacts, suggesting the surface would preserve the relative early conditions on the asteroid formation.

During its rendezvous with the asteroid, the Near-Infrared Spectrometer (NIRS) instrument on Hayabusa acquired more than 80,000 spatially resolved 0.75- to 2.20- μ m reflectance spectra from the asteroid surface under varying lighting and viewing geometry. These data allow not only to map the distribution and abundance of minerals, but also the first photometric investigation of blocky asteroid surface by narrow-band multiwavelength approach. Consequently, using these NIRS spectral data, we performed photometric and spectral mapping analyses on the global asteroid surface to examine the surface heterogeneities and these geologic context.

We derive the global photometric properties of Itokawa in terms of Hapke's photometric model. We find that Itokawa has a single-scatter albedo that is 35-40% less than that of asteroid 433 Eros. Itokawa also has a single-particle phase function that is more

strongly back-scattering than that of Eros. Despite its hummocky surface strewn with large boulders, Itokawa exhibits an opposition effect. However, the total amplitude of the opposition surge for Itokawa was estimated to be less than unity while Eros and other S-type asteroids have been found to have model values exceeding unity. The wavelength dependence of the opposition surge width reveals that coherent backscatter contributes to the opposition effect on Itokawa's surface. The photometric roughness of Itokawa is well constrained to a value of which is similar to Eros, suggesting that photometric roughness models the smallest surface roughness scale for which shadows exist.

Moreover, the photometrically corrected near-infrared spectral maps covered Itokawa surface globally were derived. The surface of Itokawa is found to present substantial albedo and spectral contrasts in near-infrared region, of which spatial patterns resemble those shown in high-resolved visible images. The variations in albedo at spatial scales of sub-meter on Itokawa range within approximately 10% that is small compared to Eros. The wavelength shift of diagnostic mineral absorption bands were not detected so that the chemical composition of the asteroid surface materials appears to be homogeneous. The observed albedo and spectral changes were well modeled by the composite optical effect of the particle size variations and space weathering maturities. We found that the surface area far from the asteroid barycenter are highly weathered, which surface heterogeneities would be related to the emplacements of impact ejecta or the asteroid formation processes.