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Analysis of The Asteroid Itokawa Surface Spectra Using Principal Component Analysis

Sumire Koga[2*], Kazuhiro Isashiki[1], Seiji Sugita[2]

[1]Dept. Sci., Univ. Tokyo, [2]Dept. Complexity Sci. and Engr. Univ. Tokyo

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Objective

The Hayabusa Spacecraft Asteroid Multi-band Imaging Camera (AMICA) obtained high spatial resolusion images of asteroid Itokawa.

In this study, we performed principal component analysis (PCA) using these multi-band images of Itokawa.

Such analysis method is usuful for analysis of Hayabusa-2 as well as First Hayabusa.

Methods

A series of images taken from approximately the same position were used for analysis. They were calibrated, ratio images of the calibrated image were made and used for PCA. PC coefficients and the proportion of variance was calculated. Also, the correlation between curvature (Cv) and inclination (Rw /Rb) of the reflectance spectrum, each of which is known as one of indice of space weathering, is confirmed.

Results and discussion

The proportion of variance of PC1 and PC2 was calculated to be about 60-70 % and 20-30 %.

It was conjectured that PC1 means the degree of spaceweathering from its coefficients, and was also implied to be plausible by matching to Previous resurch[1]. However, the significance of PC2 is not clear yet. Possible candidates are heterogeneity in composition, particle size, noise, or effect of the incompleteness of corregistration.

A positive correlation between Cv and Rw/Rb were found. However, the correlation is not very tight; further study for the large scatter is needed.

There are dark boulders called ”Black Boulders” on the ”head” of Itokawa[3]. While the other parts made one cluster in PC1 vs PC2 plot, the Black Boulder was ploted out of the main cluster. It is a good example that shows the effectiveness of PCA.

Conclusion and future work

We performed PCA for the Itokawa surface spectra. It was well implied that PC1 means the degree of space weathering. PC1 vs PC2 plot let us find that Black Boulder is peculiar easily. These shows the effectiveness of PCA. Though the meaning of PC1 is easy to understand, we have to examine what PC2 means.

References

[1] Ishiguro et al. 2007, MAPS 42, 1791.
[2] Ishiguro et al. 2010, Icarus 207, 714.
[3] Hirata & Ishiguro 2011, 42nd LPSC (2011).

Keywords: asteroid, visible spectroscopy, space weathering