

Return to Itokawa: Impact experiment on the rubble-pile asteroid

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Asteroid Itokawa is a small rubble-pile body once explored by Hayabusa-space craft, and the only asteroid that the surface sample was returned to the Earth. So, we now accumulated a lot of scientific knowledge related to this asteroid, but simultaneously the more questions are raised and waiting to be solved. Then, we propose a new possibility for the exploration of Itokawa from the point of view of re-exploration and an impact experiment on the asteroid surface.

The purpose of this mission is to deeply understand the scientific knowledge that we obtained from Hayabusa mission by means of the re-exploration of Itokawa. There is a huge advantage for the re-exploration of Itokawa compared to the exploration of the first arrival asteroid. Because we already have a detail information of geography and gravity field on Itokawa, so we can select and optimize instruments for the measurements especially for Itokawa. In this re-exploration of Itokawa, we propose an impact experiment on the surface in order to clarify the impact physics on asteroid with very low gravity field and to study the internal structure of a rubble-pile body by means of this active exploration.

The impact experiment will be conducted by using a improved Small Carry-on Impactor (SCI) developed for Hayabusa 2 space-craft. In the case of Itokawa, we already know the surface geography, and so we can determine the impact point before the exploration exactly. The improved SCI should have a self controlled system for its posture and will impact the exact point with the precision of 10m. In this moment, Muses sea is the best candidate for the cratering experiment by the SCI to study the effect of gravity on the cratering process and construct a mechanical model of the subsurface layer of rubble-pile body. This result will be an anchor for the future impact study and it should be referred to extrapolate the laboratory study to the planetary scale impact.

The artificial impact crater by the SCI will be observed by a sub-satellite for in-situ observation equipped with cameras, a dust counter and a dust LIDAR. We also plan to use a penetrator equipped with a seismometer to observe a seismic vibration by the SCI impact. The three penetrators will be set on Itokawa surface to construct a network of the seismometers and they are used to analyze the internal structure of Itokawa and to obtain the information of dynamics of granular materials under very small gravity field. In addition to the seismic observation, a radar investigation will be very effective to look through the interior of Itokawa. The sample return from Itokawa was already successful in Hayabusa, but the amount of the sample was not enough large to measure the physical properties of bulk sample. Therefore, we try to recover the sample from Itokawa surface for the study of the bulk physical properties, e.g. pebbles of Muses sea.

According to these measurements, we will construct a physical model of planetesimal, which is a virtual body in the solar nebula with an internal structure like a rubble-pile body.

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