How to investigate surface regolith on small bodies with Deployable Cameras (DCAM)

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Investigating surface regolith on small bodies becomes important since several landing/touchdown and sample return missions are ongoing (JAXA's Hayabusa2, and NASA's OSIRIS-REx) and prepared (e.g., JAXA's Martian Moons Exploration: MMX). In particular, in-situ observation/measurement of the regolith layers is useful because remote sensing observations from high altitude are limited in resolution and impossible to measure dynamic property of regolith layers, which would reflect the grain size distribution, the bulk porosity, the cohesion and so on as a consequence of the evolution of the small bodies. As a method for in-situ measurement of regolith property, we propose a small instrument that is thrown away from a spacecraft (SC) toward a target region of small body surfaces. That instrument takes pictures of the surface during falling down, measures the force or acceleration profile at the moment of landing (collision), and takes close-up images of the regolith layer after landing.

In this presentation, as an example of such an instrument, we introduce Deployable Camera system 5 (DCAM5) for in situ observation/measurement of Phobos' regolith surface. DCAM5 is the latest version of the DCAM series in space missions (DCAM1 and 2 were successfully operated in IKAROS mission and DCAM3 is equipped on Hayabusa2 mission) and now is an optional instrument in MMX mission. In MMX mission, DCAM is a small handy-sized body equipped with several visible cameras, a triaxial accelerometer, batteries, and a communication unit. DCAM will be separated from SC and thrown toward scientifically valuable regions of Phobos where SC cannot approach nor land on, e.g., inner wall of Stickney crater. As falling toward a target region, DCAM will take multiscale, multiband images of the target regions with a multiband camera equipped on the leading edge of DCAM. Multiband images with high resolutions down to ~ 1 cm/pix will reveal spectroscopic characteristics of the target region, such as the distribution of hydrated minerals and the texture of boulders which could reflect the thermal evolution of Phobos. When DCAM collides to Phobos surface, we will measure the acceleration profile at collision as an indicator of the mechanical properties of the landing point. From the acceleration profile we will obtain the disruptive strength of rocks, the penetration resistance of sands, or the compression curves of the fine powder layers, depending on the landing point. These dynamic properties reflect the mechanical and/or thermal evolution of the small bodies. After DCAM lands on the surface, we will take close-up images of the surface to clarify the size and the porosity of the surface regolith. Since DCAM is a light and small body, multiple DCAMs are preferred to be equipped and thrown toward different, interesting regions to reveal the origin and the evolution of Phobos. In addition, DCAM can be used as a reconnaissance instrument for investigating candidate landing sites of the spacecraft.

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