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Science from Small Carry-on Impactor

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Small Carry-on Impactor (SCI) is one of the instruments carried on Hayabusa-2 space craft and it will be used for the active exploration on the surface of 1999JU3. The SCI consists of a disk impactor with the diameter of 30cm made of cupper and this disk will be deformed by an explosion to form a semi-spherical shell and be accelerated to be about 2km/s for the collision on the asteroid surface. The purpose of the SCI is to enable the sampling from the interior of the asteroid, so the sample will be recovered from the floor of the artificial crater or the surrounding area covered with the ejecta from the SCI artificial crater. Moreover, the SCI will create a new fresh surface in the artificial crater without any space weathering, then the remote sensing will be able to refer this fresh surface to recognize the space weathering on other JU3 surfaces and to also observe the subsurface structure on the crater wall.

In order to confirm the ability of these observations and the sample recover in the artificial crater, we should estimate the crater size and the excavation depth in advance. We can estimate the various crater parameters formed by the SCI impact according to the conventional crater scaling law constructed by Holsapple group when the asteroid surface is assumed to be a homogeneous incompressive material like a sand layer. We can estimate the crater size, the depth of excavated material, and the maximum rim thickness for the SCI impact on the sand layer of a JU3 size body. For example, when the 2kg cupper impactor is collided on the JU3 surface, we can calculate that the crater diameter is about 5m, the rim thickness is 1m, and the maximum excavation depth is 1.2m.

However, as you know, we have no reliable mechanical data of the JU3 surface for the feasibility check of the SCI. Thus, the most important purpose of the SCI is to clarify the surface mechanical condition of the JU3. Moreover, the tiny bodies like 1999JU3 and Itokawa have a large advantage to investigate the effect of gravity on the crater formation because on the earth it is quite difficult to study the gravity effect on the crater formation, so it should be examined by the SCI impact to refine the crater scaling law related to the gravity effect. The JU3 surface is a very good plat form for the impact experiment: it is a real asteroid and the gravity is quite small and stable which can not be achieved on the earth. Thus, we consider that the SCI impact is equal to the large scale impact experiment extrapolated from the laboratory experiment.

The SCI impact will be recorded by the detached small camera or deployable camera (DCAM) and the ejecta curtain or the impact fragments will be observed to investigate the surface mechanical structure. The artificial crater will be explored by ONC, TIR, and NIRS3 to obtain the basic parameters of the impact crater and the various information of the fresh surface and the subsurface structure. These information will be used to determine the physical properties of the subsurface material and to refine the crater scaling law for the ejecta velocity distribution and the crater diameter. The cooperation with the laboratory experiments and the numerical simulations is very important to utilize the obtained results and to conduct the realistic extrapolation of the scaling law in the large scale. Our SCI science team will do our best to succeed the SCI experiment with a motto that Small Carry-on Impactor Elucidates the Nature of Craters and Ejecta (SCIENCE).

Keywords: 1999JU3, Impact experiment, Artificial impact crater, Crater scaling law, Space weathering