Introduction of the high-speed images taken in the experimental planetology

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We have made the laboratory experiments related to the impact cratering and the planetary accumulation process. The characteristics of these experiments are the observation of the phenomena which duration is a quite short less than 1ms. Therefore, we should have a high-speed camera with the exposure time less than 1 microsec. and the recording speed higher than 10^5 fps when we observe the projectile with the size of 10 mm launching at the impact velocity of 1km/s. The period during the projectile flying through the observation area is usually less than 100 microse so that we need the accurate triggering system that can synchronize the camera with the phenomenon. Recently, this system is prepared by using the digital-oscilloscope and the sensors with the short response time. Thus, we are able to use the high speed camera with the triggering system for the usual observation method.

We use two types of high-speed cameras :they are an image-converter camera (ICC) and a high-speed digital video (DHVC). The ICC can take photos higher than 10^6 fps, but the number of photos are limited to be less than 24. The recording speed of DHVC is less than that of the ICC, up to 10^4 fps, but it can record images longer than 1 sec and the acquired images are digitized, so they are quite usable for the analysis.

Hereafter, we introduce some examples of high-speed images taken by the laboratory experiments related to the high-velocity impacts. The followings are titles and explanations of these examples.

1. carck: (1) Mode I crack propagating in water ice was observed by the ICC using the lighting method with the application of the total internal reflection from cracks. (2) crack-growth and the propagation in a glass was observed by the ICC using a shadow photograph lighting system.

2. shock wave: (1) a shock wave induced in water ice by the high-velocity impact of a nylon projectile launched at the velocity of 3km/s was observed by the ICC using the shadow photograph lighting system. We observed the shock wave propagating in the form of spherical wave and it reflected from the sides, and the cracks were grown in ice by the effect of the shock pressure. (2) shock wave propagating in a gas can drive a high-speed gas flow. We observed the interaction between the gas flow and a highly porous material (cotton).

3. ejecta: (1) Impact experiments were conducted using ice balls colliding at various angles. We observed the disruption of these balls by the ICC. (2) The glass fragments made by high-speed collisions were observed by the DHVC.

4. crater: the cratering processes made on water ice, snow and ice-rock mixture were observed by the DHVC.

5. liquid droplets: The high-speed gas flow made in the shock tube can induce a strong dynamic pressure on the liquid surface. The breaking up of liquid droplets by high-speed gas flow was observed by the DHVC.

6. sticking of water ice dust: We observed the sticking of ice dust in motion with the size of smaller than 10 micron under the microscope with the DHVC.