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Impact experimental study about the relation between internal structure of small bodies and the attenuation rate of stress wave

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The populations of asteroids and comets are characterized by a great diversity in compositions and structures. In order to study the relationship between the structure of small bodies and their thermal and collisional evolution, it is therefore important to have a good knowledge of their impact response as a function of their physical properties. The results of the experiments will be used as a reference for future numerical simulations of collisional process of porous bodies.

In our previous study, impact experiments on porous targets consisting of sintered glass beads have been performed at different impact velocities in order to determine the disruption impact energy threshold (also called $Q*$) of these targets, the influence of the target compressive strength on this threshold and a scaling parameter of the degree of fragmentation that takes into account material strength. A large fraction of small bodies of our Solar System are expected to be composed of highly-porous material. As a result, we found that the value of $Q*$strongly depends on the target compressive strength.

Then, new impact experimental series were performed by using sintered glass beads for the purpose of studying the attenuation of the stress wave in the porous targets in both high and low velocity impacts and in both porous and dense targets. Porous targets which have 39% porosity were disrupted by helium light-gas gun (low velocity) and two-stage light-gas gun (high velocity) and dense targets which have 32% porosity were disrupted by two-stage light-gas gun. The antipodal velocities of the targets were measured by using high-speed camera images taken at 2,000 - 64,000 fps. In the results of these experiments we do not find a major dependency of the stress wave attenuation rate on both the compressive strength and the impact velocity. The difference of porosity of these two sets of targets did not have a big influence either (Setoh et al. 2008).

Furthermore, to investigate the attenuation rate of the stress wave transmitted in small bodies that have various internal structures, the impact experiments of non-porous glass bead powder were performed. An acrylic cylinder filled with the powder target consist on 50 micron glass beads that was same as the previous sintered targets, and front of the target were capped by the paper and opposite side of the target were capped by aluminum foil that had a small hole. Glass bead particles did not spoil by the frictional force. The projectile penetrated into the paper and antipodal particle velocities were measured by the high-speed video images. Antipodal velocities normalized by impact velocities and target thickness normalized by projectile radius were compared as well as the sintered targets and the attenuation rate was measured. At the result of these experiments, the power law index was about -2 and that was similar to sintered targets though these were high-velocity experiments or low-velocity experiments.

This time, to investigate the relation between internal structure and the pressure attenuation rate of simulated small bodies more in detail, we performed similar experiments with targets that have different particle size. And we also performed low-velocity impact experiments under microgravity condition using parabolic flights in order to investigate effect of particle compression by gravity. We will present the comparison of the results of these experiments.