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**The projectile shape and material effect on the momentum transfer  
for asteroid orbit change**

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**ABSTRACT**

In this study, we discuss a momentum transfer which is used the spacecraft impact for an asteroid orbit change. There are two efficient methods to deflect the asteroid. It is spacecraft impact and nuclear explosion because these are not necessary to attach equipment on the asteroid and give energy to deflect in a moment. The nuclear explosion is better way to give the energy than the spacecraft impact. However, it has the risk that it destroys the asteroid and produces some huge fragments which can't be controlled by the splitting the asteroid. Therefore, this study focus on the spacecraft impact. An effect of the spacecraft impact is evaluated by  $\beta$ . The  $\beta$  is ratio of an output momentum the asteroid obtains to an input momentum the spacecraft has. The output momentum is known to be greater than the input momentum due to secondary debris called ejecta. The  $\beta$  are affected by various factors. In this study we focused on two factors. It is a shape and material of the

projectile. The others studies considered the influence of the projectile shape and material by a numerical analysis. However, experiments have not been performed.

Therefore the purpose of this study is to reveal the projectile shape and material effect tendency and identify the respective shape and material from experiments using some projectiles. We performed the experiments in about 1.2 km/s to 3.8 km/s with a Two Stage Light Gas Gun. Then, we compared the ejecta mass and  $\beta$ . Also we compared results by using a scaling law to examine the actually  $\beta$  in case that the spacecraft impact with a huge mass and the impact velocity is more than 10 km/s

To research shape effects we performed experiments with five types of projectiles shapes. The projectile shape is shown in Table 1. These projectiles material were aluminum alloy. Also, we compared four materials in the sphere shape. We used copper, titan, steel and aluminum alloy for the projectile material.

Table 1 Projectile shape

	Cylinder	Cone	Punch	Cup	Sphere
shape					