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Experimental Studies on Impact Disruption of Rocky Rubble-Pile Bodies

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Rubble-pile bodies, which are constructed from the rocky fragments accumulated gravitationally, are common in the history of the solar system. It is important to evaluate the effect of the rubble-pile structure on the impact disruption in order to clarify the collision process of the solar system bodies. In particularly, the impact strength Q_{D*} is an important parameter for planetary collisional evolution. Then, we carried out high velocity impact experiments using several types of rubble-pile targets constructed from glass beads, and we examined the disruption condition of these rubble-pile targets. It is found that a lot of intact beads of rubble-pile targets were ejected very slowly and the enormous impact energy is necessary to shatter all of the beads constructing the rubble-pile targets. We defined the total mass of the small fragments M_{fsum} as a new parameter of impact disruption for rubble-pile targets, and calculated the crater volume for rubble-pile targets using this parameter, the crater volume is defined by the region where the beads are broken catastrophically. We compared them to that formed on for homogeneous basalt targets by using P_i-scaling and found that the crater on rubble-pile targets was larger than that on basalt targets. Furthermore, in order to understand the characteristics of the impact disruption for rubble-pile targets, we estimated the attenuation rate n of the shock pressure decay with the distance by assuming a billiard collision model and we obtained n=1.6~2.7 for the power law index of the propagation distance. From these results, we calculated the energy fraction f defined by the kinetic energy of the projectile transferred into the kinetic energy of the intact beads and we estimated the Q_{D*} of rubble-pile bodies from the re-accumulation condition of the dispersed intact constituents.

Keywords: Rubble-pile body, Impact disruption