Oral | Symbol P (Space and Planetary Sciences) | P-PS Planetary Sciences

[P-PS21_29AM2]Planetary Sciences

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We call for general interest papers for Planetary Sciences. Planetary Sciences consist of a variety of studies on the past, present, and future of our solar system and exoplanetary systems. Discussions based on various backgrounds are encouraged.

12:30 PM - 12:45 PM

[PPS21-P15_PG]Experimental study on the decay process of impact-induced stress propagating through granular materials

3-min talk in an oral session

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Keywords:Excavation flow, Granular material, Cratering process

Introduction: Impact process is one of the most important physical processes in the solar nebula. In order to understand the impact histories related to planetary formation process, it is important to study the impact cratering process and the scaling law. Impact cratering experiments have been performed on granular material, and the crater size is found to be different depending on the target material. So, it is necessary to study how physical properties affect the cratering process, especially for excavation stage. Excavation flow is a main process that controls the crater size, so we should examine the effects of material properties. However, it is difficult to observe the flow inside the target, so we used the in-material sensor to measure the pressure. The pressure distribution in the granular target would show the flow and we can compare the crater size and the pressure distribution to clarify the effect of target materials on the crater formation process. Experimental method: We prepared a target container with a pressure sensor to measure the stress generated by impact. It is made of aluminum with the size of 10cm×10cm×10cm, and we changed the depth of the granular target from 1 to 10cm. The pressure sensor (20kPa, ≤2kHz)was attached on the bottom of the container just below the impact point, and impact experiments were conducted by a free-fall or by a one-stage vertical He-gas gun in Kobe University. We studied the effects of projectile size and impact velocity on the crater size and the stress wave. We used glass beads and quartz sand with the diameter of 100 and 500μ m as granular target, and glass balls (φ=7.75, 10, 15mm) in free-fall, nylon and alumina (φ= 3mm) in vertical gun experiments as projectile. Impact velocity is 2-5.5m/s in free-fall and 60-70m/s in vertical gun experiments. We observed crater size and pressure wave in each experiment.Results: We found that the size of the impact crater strongly depends on the granular materials, that is, the crater formed on the quartz sand was systematically smaller than that formed on the glass beads. Then, we found that the pressure wave increased suddenly and decreased with a relaxation time depending on target materials. The relaxation time is small for quartz sand and long for glass beads, and the relaxation time of 100μ m quartz sand was not measured because of normal mode oscillation of the pressure sensor: it means that the time is less than 0.5ms. Although the normal mode oscillation of the sensor was observed in the high velocity impact and the shallow depth impact in the case of gas gun experiments, we analyzed the peak of measure pressure waves (P_{max}) and obtained the relaxation time (τ) by fitting them with the following function: $P(t)-P(\infty)=A\exp(-t/\tau)$, where t is time after the impact. As a result, τ is obtained to be 1ms for glass beads target irrespective of the bead size, and 0.1ms for 500μ m quartz sand. The relationship between the pressure and the propagation distance was described by $P(r)=P_0(r/L)^{-b}$, where L is a projectile radius, r is distance, P_0 is an initial impact pressure, and b is a decay constant. The decay constant was found to change with the impact velocity and the target materials: it was derived to be 0.79,0.94 in a low velocity range, 1.61,1.71 in a high velocity range for glass beads, quartz sand.We found that the relationship between the crater size and P_{max} at 4cm depth was different in each granular material. The crater size of the glass beads target was larger than that of the quartz sand at the same P_{max} . Then, we introduce a new parameter expressed by τ times P_{max}, so called impulse, *I*. We renewed the relationship using *I* instead of *P_{max*