[EE] Evening Poster | P (Space and Planetary Sciences) | P-PS Planetary Sciences

[P-PS02]Regolith Science

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Recent planetary explorations have revealed that almost all solid bodies in the solar system are covered with small particles, called regolith. The surface geology, especially regolith behavior on the surfaces of solid bodies, becomes increasingly more important as represented by Hayabusa mission and other on-going and planned sample-return missions such as Hayabusa2 going to an asteroid Ryugu, OSIRIS-REx going to an asteroid Bennu and MMX planning to go to the martian satellites.

For fully understanding the regolith science, it is required to know and compare the regolith conditions on various celestial bodies, from asteroids to planets, with various methods.

Therefore, this session welcomes broad topics related to regolith on various celestial bodies, such as asteroids, comets, the Moon, the martian moons, Mars, etc. Papers on the formation, evolution, and alteration processes of regolith particles and regolith systems on the surface of planetary bodies, remote and in-situ observational results and techniques, analyses and results of returned samples, and laboratory, numerical, and theoretical studies on the fundamental physical and chemical processes are all welcome.

[PPS02-P01]Experimental study of low velocity impact onto granular media under reduced gravities: Effects of density ratio of the projectile to the target

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Impact cratering is a ubiquitous geophysical process on planets and small bodies. A scaling law with dimensionless parameters has been formulated based on a large number of impact experiments (Holsapple, 1993). Hypervelocity impacts onto granular materials under low (Gault and Wedekind, 1977) and high (Schmidt and Housen, 1987) gravity showed that crater diameter was proportional to ga/v^2 to the power of about -0.17, where g, a, and v are the gravitational acceleration, projectile radius, and impact velocity, respectively (Gault and Wedekind, 1977; Schmidt and Housen, 1987). In contrast, low-velocity impact experiments onto granular materials at 1 G showed that the crater diameter was proportional to the impact energy, i.e., δa^3v^2, to the power of one-quarter, where δ is the projectile density, except for craters formed by dense projectiles (Uehara et al., 2003; Walsh et al., 2003). The impact velocity dependence of crater size is inconsistent between the hypervelocity and low-velocity impact experiments. In addition, the gravitational dependence of crater size at low-velocity and the effect of density ratio of the projectile to the target on crater size has not been understood in detail.

We developed a drop mechanism which can simulate gravities smaller than 1 G: a target container was suspended by springs of constant force. We conducted impact experiments under a gravity range between 1 and 0.25 G. As the target material, we used silica sand of average diameter (140 μm). We used projectiles with different densities: stainless steel spheres of 7.9 g cm^{-3} and glass spheres of 2.5 g cm^{-3}. The diameter of

the projectiles was 8 mm. The impact velocities were between 1.0 and 4.6 ms^{-1}. As a result, crater diameters formed by steel projectiles were proportional to the impact velocity to the power of -0.41 ± 0.01 and proportional to the gravitational acceleration to the power of -0.22 ± 0.01 (Kiuchi and Nakamura, 2016 JPGU meeting). We confirmed that the impact velocity and the gravitational dependence represented for the steel projectile in this study was slightly larger than the value obtained in a previous study with high impact velocity (Gault and Wedekind, 1977). On the other hand, crater diameters formed by glass projectiles were proportional to the impact velocity to the power of -0.49 ± 0.02 and proportional to the gravitational acceleration to the power of -0.12 ± 0.01. The impact velocity dependence of the crater diameter for glass projectiles has been shown to follow the energy scaling. On the other hand, the gravitational dependence for glass projectiles (0.12) was weaker than the energy scaling (0.25) and the result of steel projectiles (0.22). We predict that the difference in the penetration depth of the projectile affect the final crater size. The density ratio of the projectile to the sand target was 5.3 for the steel projectile and 1.7 for the glass projectile. Larger density ratio leads to larger penetration depth of the projectile, as long as the projectile does not break (Okamoto et al., 2013). We estimated the penetration depth based on an empirical formula (Katsuragi and Durian, 2013). Combining the penetration depth with the present results, it could be said empirically that the crater diameter may not follow the energy scaling when the penetration depth of the projectile is larger than about one diameter of the projectile in low-velocity regime. The deviation from energy scaling may be caused by energy consumption by the penetration of the projectile or by insufficient crater excavation due to the deeper source of the excavation flow.