The effect of gravity acceleration and internal friction angle of regolith on impact crater size on asteroid surface

Masato Kiuchi[1], Akiko M. Nakamura[1]

[1]*Kobe University, Japan*

Because gravitational acceleration at an asteroid surface is very small, it is not known which scaling should determine the size of an impact crater, gravitational scaling or strength scaling. In order to estimate the evolutional processes of asteroid surfaces, it is important to understand the gravity dependence of crater diameter. However, not many impact cratering experiments under low gravity conditions have been conducted. A few hypervelocity impact experiments were conducted under increased gravities (Schmidt and Housen, 1987) and under low gravities (Gault and Wedekind, 1977; Takagi et al., 2007). These studies show different gravity dependences and further study is required to understand why the results look inconsistent.

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 experiments under a gravity range of 0.25-1 G. We used silica sand of average diameter 140 μm and glass beads of average diameter 500 μm as the target material. Stainless steel sphere of 8 mm diameter was dropped and impacted onto the target. The impact velocity was between 1 and 4 ms^{-1}. As a result, the crater diameter formed under the gravity range between 0.25-1 G was proportional to -0.188 ± 0.008 power of the gravity acceleration for the silica sand and -0.183 ± 0.007 for the glass beads. These values are roughly in agreement with previous studies at hypervelocity (Schmidt and Housen, 1987; Gault and Wedekind, 1977).

Internal friction angle of granular material is important factor for crater size. A crater formed on particles which have large internal friction angle is typically smaller than the one formed on particles which have small internal friction angle. The internal friction angle is related to particle shape, for example, spherical particles have smaller internal friction angle than irregular shaped particles. It is shown that the internal friction angle under ultra-high vacuum was larger than the one under 1 atm (Perko et al., 2001). Because ambient pressure at the surface of an asteroid is very low, it is important to examine a relationship between the internal friction angle and the crater size.

We conducted low velocity impact experiments onto granular materials with different internal friction angle and obtained a relationship between internal friction angle and crater size. We applied this relationship to an environment of asteroid surface by considering the relationship between internal friction angle and ambient pressure and will present the results.