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An experimental study of low velocity impacts into granular material in reduced gravity

Naomi Murdoch (1), Iris Avila Martinez (1), Cecily Sunday (1), Olivier Cherrier (1), Emanuel Zenou (1), Tristan Janin (1), Alexandre Cadu (1), Yves Gourinat (1,2), and David Mimoun (1)

(1) Institut Supérieur de l'Aéronautique et de l'Espace, Toulouse France, (2) Institut Clement Ader (ICA FRE3687-CNRS), Toulouse, France

The granular nature of asteroid surfaces, in combination with the low surface gravity, makes it difficult to predict lander - surface interactions from existing theoretical models. Nonetheless, an understanding of such interactions is particularly important for the deployment of a lander package. This was demonstrated by the Philae lander, which bounced before coming to rest roughly 1 kilometer away from its intended landing site on the surface of comet 67P/Churyumov-Gerasimenko before coming to rest (Biele et al., 2015). In addition to being important for planning the initial deployment, information about the acceleration profile upon impact is also important in the choice of scientific payloads that want to exploit the initial landing to study the asteroid surface mechanical properties (e.g., Murdoch et al., 2016).

Using the ISAE-SUPAERO drop tower, we have performed a series of low-velocity collisions into granular material in low gravity. Reduced-gravity is simulated by releasing a free-falling projectile into a surface container with a downward acceleration less than that of Earth's gravity. The acceleration of the surface is controlled through the use an Atwood machine, or a system of pulleys and counterweights. In reducing the effective surface acceleration of the granular material, the confining pressure will be reduced, and the properties of the granular material will become more representative of those on an asteroid's surface. In addition, since both the surface and projectile are falling, the projectile requires a minimum amount of time to catch the surface before the collision begins. This extended free-fall increases the experiment duration, making it easier to use accelerometers and high-speed cameras for data collection.

The experiment is built into an existing 5.5 m drop-tower frame and has required the custom design of all components, including the projectile, surface sample container, release mechanism and deceleration system (Sunday et al., 2016). Previous experiments using similar methods have demonstrated the important role of gravity in the peak accelerations and collision timescales during low velocity granular impacts (Goldman and Umbanhower, 2007; Alsthuler et al., 2013). The design of our experiment accommodates collision velocities and effective accelerations that are lower than in previous experiments (<20 cm/s and $\sim$0.1 - 1.0 m/s^2, respectively), allowing us to come closer to the conditions that may be encountered by current and future small body missions.

[1] Altshuler, E., et al., "Extraterrestrial sink dynamics in granular matter", arXiv 1305.6796, 2013.
[2] Biele, J., et al., "The landing(s) of Philae and inferences about comet surface mechanical properties", Science, 349 (6247), 2015.
[3] Goldman, D. I., Umbanhowar, P., Scaling and dynamics of sphere and disk impact into granular media, Physics Review E 77 (2), (2008) 021308.

[4] Murdoch, N., et al. "Investigating the surface and subsurface properties of the Didymos binary asteroid with a landed CubeSat", EGU, 2016.
[5] Sunday, C., et al., "An original facility for reduced-gravity testing: a set-up for studying low-velocity collisions into granular surfaces", Submitted to the Review of Scientific Instruments, 2016.