Extraterrestial sink dynamics in granular matter

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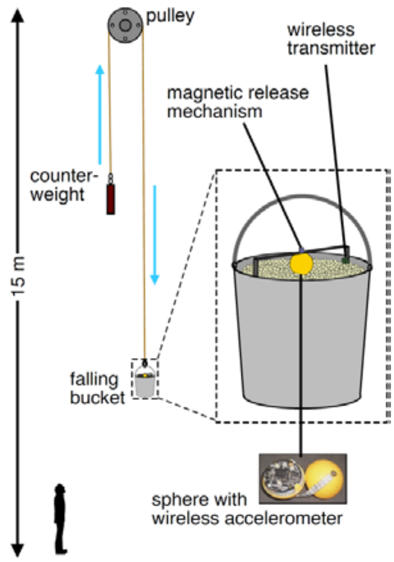
While the penetration of objects into granular media is well-studied, there is relatively little understanding of how objects settle in gravities, g_{eff}, different from that of Earth—a scenario potentially relevant to the geomorphology of planets and asteroids and also to their exploration using man-made devices.

The seminar is divided in two parts. Firstly we present our previous results on the penetration of a spherical object into a long silo of very light granular matter, described by an equation of motion that also predicts the possibility of infinite penetration.

Then, we present our experimental results on the penetration of a sphere into a silo of granular matter which experiences different gravities, g_{eff}, thanks to a “lab-in-a-bucket” set-up. We explore g_{eff} ranging from 0.4 g to 1.2 g. Surprisingly, we find that the rest depth is independent of g_{eff} and also that the time required for the object to come to rest scales like $g_{eff}^{-1/2}$. With discrete element modeling simulations, we reproduce the experimental results and extend the range of g_{eff} to objects as small as asteroids and as large as Jupiter. We are also able to predict the main experimental results using the equation of motion presented in the first part of the seminar.

Our results may shed light on the initial stage of sedimentation into dry granular media across a range of celestial bodies and may also have implications for the design of man-made, extraterrestrial vehicles and structures.



Lab-in-a-bucket: performing variable-gravity experiments on a ridiculous budget. Left: Sketch of the experimental setup. Above: The *Lab-in-a-bucket* crew.