The Strata-1 Microgravity Experiment on Small Body Regolith Dynamics

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Introduction: The behavior of surface dust created by meteoroid bombardment (regolith) on large bodies such as the Moon has been well studied and characterized [1]. However, regolith dynamics on small bodies with microgravity environments are still not well understood. To address this, we are flying the Strata-1 microgravity experiment aboard the International Space Station (ISS), which creates a gravitational environement very similar to that on an asteroid. Without the influence of substantial gravity, secondary forces such as inter-particle forces, diurnal thermal cycling, impact gardening, YORP induced avalanches, and orbital evolution effects dominate the surface processes and motion of the grains [2]. Strata-1 will help validate existing models of the evolution of regolith on the surfaces of small bodies (asteroids, comets), which can be of significant use for future exploration missions to these objects.

The experiment consists of four cylindrical vacuum chambers each with a different type of simulant used to characterize the long-term dynamical processes affecting the distribution of regolith on airless surfaces on small bodies (see Figure 1 which shows the contents of each chamber). ISS' vibrational environment provides a useful platform to address some of these effects as it delivers perturbations simulating the shocks from impact events generally analogous to those on small bodies.

The data are collected via four hi-resolution cameras that save images to SD cards at periodic intervals. As the vibrations from capsule docking or routine maintenance disturb the material in the chambers, we track the rates and magnitudes via onboard three-axis accelerometers, and correlate these motions with the observed changes in the chambers. Day/night activity cycles of the crew's activities and long-term orbital perturbations also provide vibration over a range of frequencies that mimic the diurnal and long-term environment on a comet or asteroid.

We are currently analyzing over 70GB of images covering the first six months of the year-long experiment in microgravity. So far we have observed interesting phenomena occuring in the chambers, with each one demonstrating different behavior. Aggregate formation is occuring in the simulant material during small vibratory events in Chamber 2, with eventual disruption during larger events (e.g. docking). Chambers 2 and 3 both have layering effects taking place, with fractures and particle sorting inside Chamber 3. The crushed glass inside Chamber 4 is highly mobile, repeatedely re-ordering itself with possible Brazil Nut effects present.

We will present the results from the analyses currently underway on Chamber 2 including size distributions of formed aggregates, time-series analysis of the fracturing/layering of the material, and the correlation with vibrational events on the ISS via accelerometer data. To accomplish this, we are analyzing the raw and thresholded images using tracking software (ImageJ) for edge/line detection and particle counting. With these analyses we can show the formation timescale for dusty aggregates and possibly infer something about their strengths.

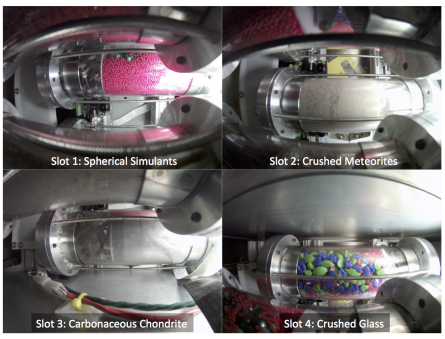

Figure 1. The four chambers in the Strata-1 experiment containing different regolith simulants. Each chamber's simulant contains a distribution of roughly three particle sizes or sieved particle size ranges.

References: [1] Papike et al (1982) *Rev. of Geophys. and Space Phys., 20*, 761-826 [2] Scheeres et al (2010) *Icarus, 210,* 968-984