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Introduction: Granular convection is a process often invoked by the community of small-body scientists to interpret the surface geology of asteroids. For example, Miyamoto et al. [1] suggest that the arrangements of the gravels on Itokawa's surface are largely due to granular convective processes. It has also been suggested that, "all other considerations aside, granular convective processing is favored by microgravity" [2]. The convective flow in granular matter that is the subject of most research is the vibration-induced type (e.g. [3],[4],[5]). Convective-like flows in a granular material have also been seen using the Taylor-Couette geometry (e.g. [6],[7]). However, in all of these experiments a pressure gradient occurs within the medium due to the Earth's gravititational field.

Experiment: We use a modified Taylor-Couette shear cell (Fig. 1) to investigate, for the first time, convective-like flows in a granular material under the conditions of parabolic flight microgravity. The experiment consists of two concentric cylinders. The outer cylinder is fixed and its inner surface is rough with a layer of glued on particles; the outer surface of the inner cylinder is also rough but it is free to rotate, and the floor between the two cylinders is smooth and fixed in place. The gap between the two cylinders is filled with granular material on which the rotating inner cylinder applies shear stresses.

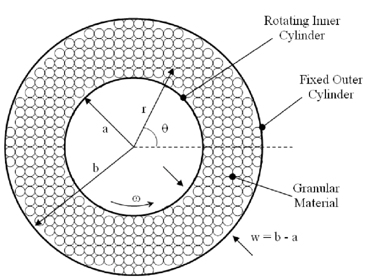

Figure 1 : The Taylor-Couette Geometry [7]. (a = Inner Cylinder Radius, b = Outer Cylinder Radius, w = Width of Shear Region, r = Radial Distance, θ = Angular Distance, ω = Inner Cylinder Rotation Rate)

Results: The radial velocity profiles of particles on the top surface of the cell in ground-based experiments exhibit a large dip close to the inner cylinder, which is indicative of convective-like motion (Fig. 2). However, this dip is not present in the radial velocity profiles of microgravity experiments. This indicates that there is a mechanism causing the inward motion of particles on the top surface in the presence of an external gravitational field. This mechanism does not seem to be active in microgravity. This finding is further confirmed when we examine how the mean particle radial velocities vary in time over the course of a parabola as the simulated gravity changes.

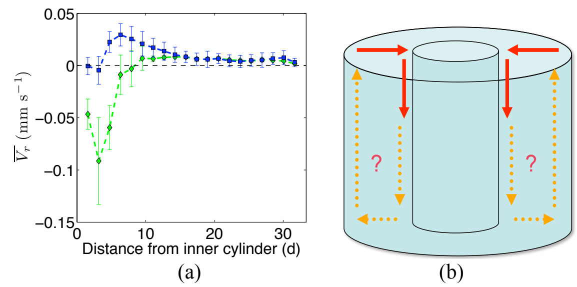

Figure 2: (a) Mean radial velocity of particles, plotted as a function of distance from the inner cylinder in particle diameters, for experiments with an inner cylinder angular velocity of 0.05 rad s^{-1}. Results are shown for ground-based experiments (green diamonds) and microgravity experiments (blue squares). (b) Schematic of radial flow in ground-based experiments. The mean negative radial motion implies that convective-like flows are occuring. However, from imaging just the top surface it is not possible to know whether there is one large convective cell within the bulk or several smaller ones.

Conclusions: Convective-like flows seem to occur in our experiment in the presence of an external gravitational field but not in microgravity. Therefore, a weak gravitational acceleration, such as the one found at the surfaces of small bodies, may reduce the process of granular convection. Any granular processes involving granular convection may therefore require much longer timescales than when in the presence of a strong gravitational field.

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