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Convective states and patterning behavior in Lunar Regolith under the effect of vertical vibrations

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Abstract:

In the field of space exploration, it is essential to deal with solid "particles" for various applications, for example transporting lunar and Martian soil (typically regolith), for mining, to study geological aspects and establish habitats on the Moon or Mars. However, methods to handle these materials remain untested because they are made of abrasive and reactive components which by their nature make them hard to handle mechanically. In the present project, novel strategies to manipulate such granular systems based on the application of "vibrations" are explored. Special attention is devoted to the unique states which are produced when such materials are subjected to concurrent vibrations and gravity (vertical shaking). By means of a concerted approach based on experimental work in synergy with relevant computational tools for systems where the assumption of continuum is not applicable, we show that circumstances exist where lunar regolith can behave as a kind of "fluid" and produce interesting patterning behaviors. The problem is parametrically investigated by allowing the frequency and spatial amplitude of the imposed vibrations to span relatively wide intervals for different depths of the considered layer of material (simulant). The results are critically discussed and placed in a proper theoretical context through comparisons with earlier experimental findings where the analysis was limited to monodisperse collection of particles (spheres with fixed density and diameter as opposed to the irregular shape and varying size of lunar regolith).