Faraday Heaping Unravelled: Study of Heaping Behavior of Granular Materials under Vertical Vibration

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Heaping behavior of granular materials under vertical vibration has attracted increasing interest in recent years as it is a beautiful example of gas-granular interaction and granular hydrodynamics. A major challenge with current understanding of the phenomenon is the complexity of the internal granular flow. Furthermore, heaping behavior under complicated conditions also give rise to new regimes in granular physics waiting to be explored. Therefore, the purpose of this research is to determine the mechanism of the internal granular flow field and explore new regimes of heaping behavior of foam particles under vibration. In this study, a power law between air pressure and heaping intensity was obtained by performing experiments under different vacuum levels. Internal granular flow field was experimentally determined by tracking particle behavior in granular mixtures, revealing its physical mechanism as the combined effect of air pressure and gravity. Heaping anomalies were observed and investigated at high vacuum levels. A model was developed based on experiments and adapted to heaping and coarsening process, thus completing the investigation of classic Faraday heaping. This research further explored heaping behavior of low-density foam particles and discovered high-density clustering within the top levitated part of the granular heap at high frequencies, suggesting that active system might exist in this classic granular system. These discoveries not only offered fresh insight to granular hydrodynamics and examined the nature of classic granular system under vibration, but also provided potential value for industrial applications such as processing and transportation of granular materials and explaining natural processes such as earthquake-induced landslides.

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