Active Heaping: New Clustering and Heaping Phenomenon Discovered in Strongly Shaken Granular Matter

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The dynamic behavior of granular matter under vibration puzzles soft matter physicists today, and remains a major branch of modern soft matter research. This research first analyzed a classic phenomenon in vibrated granular systems called Faraday Heaping, and explored its new regimes by studying the dynamic behavior of low density particles under vigorous high-frequency vibration. We discovered a new phenomenon with levitated clustering and new forms of heaping. Our observation & analysis of the new phenomenon discovered dynamic high-density clustering, granular self-organization and steady granular flows within the system. Through extensive single-particle tracking, trajectory and speed analysis, we revealed the ballistic movement and drunken trajectory of the particles. This particular type of movement is highly consistent with that of active systems. Therefore, we believe that the mechanism for granular clustering is the effect of coupling due to active behavior of the particles. This research further studied the underlying mechanism of this effect. Through experimenting with quasi-sealed containers and injecting colored smoke, we confirmed the dominating effect of air current. We visualized and confirmed the flow pattern of air current and discovered the role of air in levitating the cluster and keeping its shape. Therefore, we revealed the primary mechanism for the new clustering and heaping behavior. This research discovered and explained a new clustering and heaping behavior in granular physics. Our discovery provided fresh insights to granular systems, pushed the boundaries of physics regimes and offered new perspectives for developing smart materials and new structures.