Competitive Clustering in a Bidisperse Granular Gas

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ABSTRACT

A bidisperse granular gas in a compartmentalized system is experimentally found to cluster *competitively*: Depending on the shaking strength, the clustering can be directed either towards the compartment initially containing mainly small particles or to the one containing mainly large particles.

A mixture of large and small beads, in a compartmentalized container, is shaken vertically to form a bidisperse granular gas. At vigorous shaking the beads spread out as in any ordinary gas, but when the shaking strength is reduced below a critical level the beads cluster together, due to the fact that in every collision some of their kinetic energy is dissipated. We find that by tuning the shaking strength this clustering can be *directed*: One can let either the large or the small beads win.

At moderate shaking the beads cluster into the compartment initially containing the majority of large particles. This is just as expected, since here the initial total particle mass −and hence the dissipation rate− is larger. Reducing the shaking even further, the beads surprisingly cluster into the other compartment, where most of he smaller particles were in. The series of events is as follows: At first, the large beads stay close to the bottom. On top of them, the smaller beads jump higher than they would on the plain floor, just like tennis balls on top of a basketball. This effect is stronger in the left box −which has more large beads− than in the right box, and thus the small beads go preferentially into the latter. Once the small ones have left, the large beads become more mobile too and follow one by one. The second clustering process (lower row) takes much longer than the first (upper row). The observed time scales are in good agreement with the predictions from a flux model describing the particle flow between the compartments.

The conditions under which this competitive clustering occurs are studied experimentally, numerically (by means of molecular dynamics simulations), and analytically. A minimal model is derived that quantitatively accounts for the observed phenomena.

REFERENCES

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