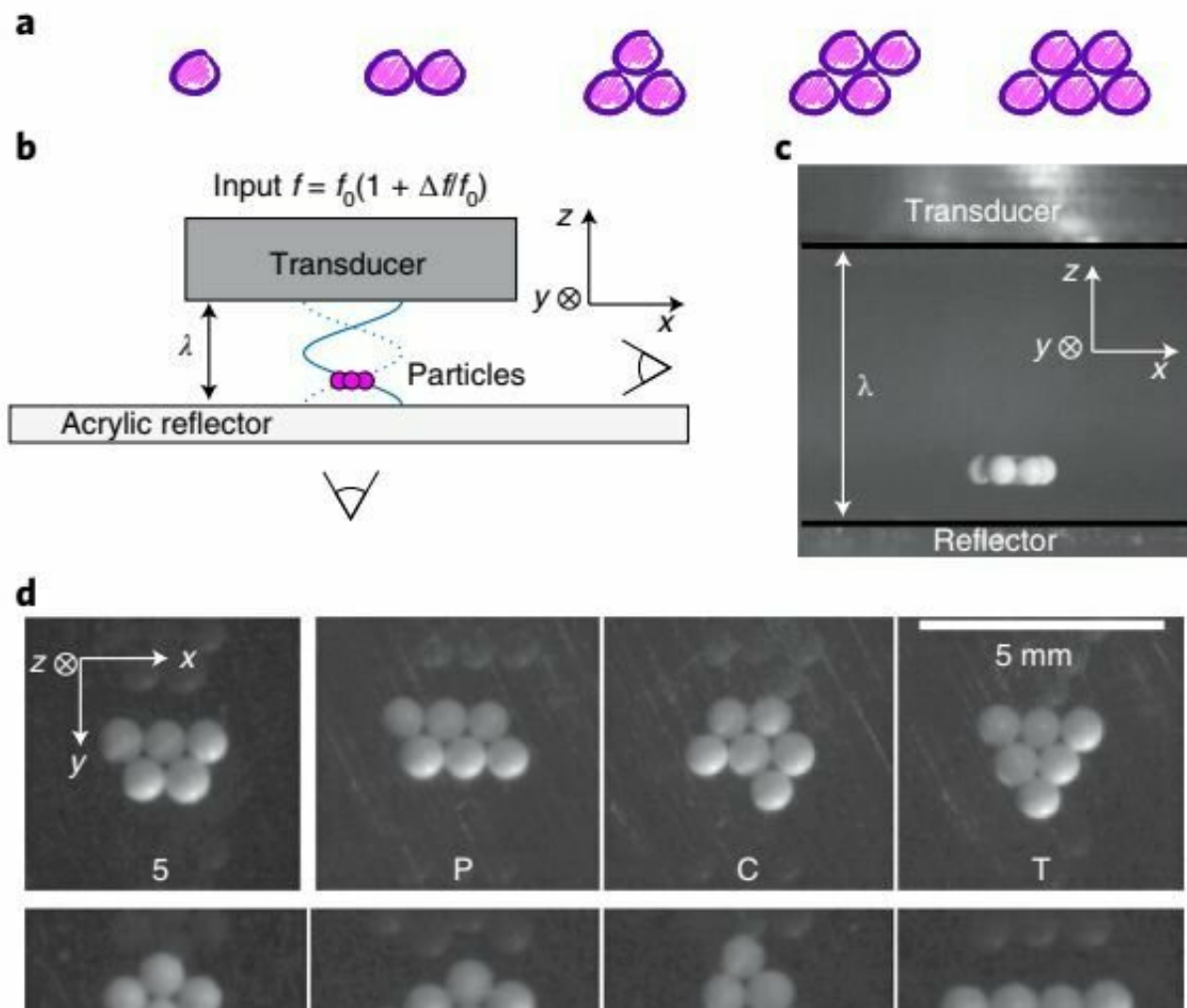


Assembly in the air: Using sound to defy gravity

March 4 2019



Assembling and manipulating clusters composed of macroscopic particles using acoustic levitation. a, Sketches of compact cluster configurations (isostatic ground states) for one to five particles. b, Schematic of the experimental set-up. An ultrasound transducer generates sound waves in air, with speed of sound $c_s =$

343 m s⁻¹. The distance between the transducer and the transparent acrylic reflector is chosen to create a pressure standing wave (blue line) with two nodes, at frequency $f_0 = 45.65$ kHz and wavelength $\lambda = c/f_0$. Polyethylene particles are acoustically levitated in the lower of the two nodes. c, Image of cluster from the side. Clusters are also imaged from below via a mirror (d). d, Different cluster configurations, imaged from below. Top: in two dimensions, there is only one five-particle cluster configuration, but six particles can form one of three distinct ground states: parallelogram P, chevron C and triangle T. Bottom: seven-particle clusters have four compact configurations: flower (Fl), turtle (Tu), tree (Tr) and boat (Bo). Credit: *Nature Physics* (2019). DOI: 10.1038/s41567-019-0440-9

Scientists at the University of Bath have levitated particles using sound in an experiment which could have applications in so-called "soft robotics" and help reveal how planets start to form.

The research team, from the University of Bath and the University of Chicago, were interested in how materials cluster together when they're not on a hard flat surface.

They used [sound waves](#) to levitate [particles](#) of around 1mm in diameter and studied how these particles, made of the common plastic polyethylene, interact with each other in 2-D in small groups of six or seven.

When there are five particles or fewer the particles cluster in only one configuration. However, when there are at least six particles, there are a number of [different shapes](#) they could assemble into when brought together, as the scientists found.

By levitating the particles and using high-speed cameras the researchers were able to capture these various configurations. They found that groups of six particles can form three shapes: parallelogram, chevron,

and triangle.

Adding one more particle to make seven meant that particles clustered together in one of four shapes, each resembling a flower, a turtle, a tree, or a boat.

The team discovered that by changing the sound-wave frequency, they could manipulate the clusters and influence the emergent [shape](#). They found that rearranging the shapes often depends on one particle acting as a "hinge" and swinging around the others to reconfigure, which could be very useful in a range of potential applications.

Dr. Anton Souslov from the University of Bath Department of Physics said: "Six particles is the minimum needed to change between different shapes, which is where things get interesting.

"We've found that by changing the ultrasound frequency, we can make the particle clusters move about and rearrange. This opens up new possibilities for manipulating objects to form complex structures. Maybe these hinges that we observe could be used to develop new products and tools in the fields of wearable technology or [soft robotics](#)—where scientists and engineers use soft, manipulable materials to create robots with more flexibility and adaptability than those made from rigid materials.

"Understanding how to control ultrasonic forces is really important—ultrasound is already used throughout industry and in household products from making tiny droplets in humidifiers (for dry Chicago winters) to cleaning gunk off hard surfaces. For us scientists, defying gravity to levitate dust also has this more fundamental interest of developing earth-based experiments to understand how bodies in space like planets and moons start to form when space dust begins to agglomerate together."

The study is published in *Nature Physics*. The research team now intends to look at how acoustic levitation can bring together larger numbers of particles to assemble more complex structures.

More information: Cluster formation by acoustic forces and active fluctuations in levitated granular matter, *Nature Physics* (2019). [DOI: 10.1038/s41567-019-0440-9](https://doi.org/10.1038/s41567-019-0440-9) ,
www.nature.com/articles/s41567-019-0440-9

Provided by University of Bath

Citation: Assembly in the air: Using sound to defy gravity (2019, March 4) retrieved 9 April 2024 from <https://phys.org/news/2019-03-air-defy-gravity.html>

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