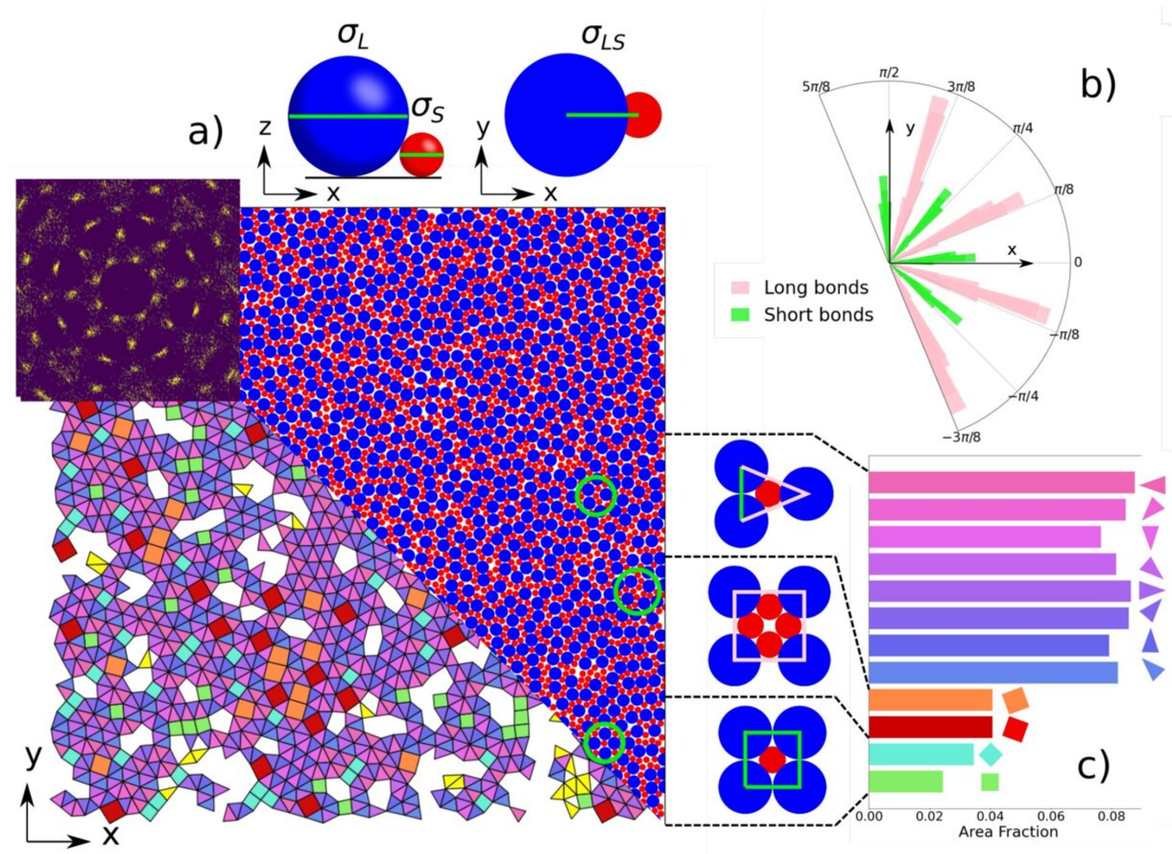
Spontaneous quasi-crystal self-assembly observed using tiny vibrating magnetic spheres

July 19 2023, by Bob Yirka



Numerical results obtained with EDMD of the collisional model defined in Eqs. 1. Here $\{q, xS, \phi\} = \{0.5, 0.68, 0.85\}$, $NS + NL = 5000$, $\alpha = 0.95$, $\Delta = 0.02$. a) Sketch of the granular non-additive hard-core interactions, final configuration, reconstructed tiling and structure factor. b) Bond orientation histrogram. c) Histogram of the area fraction occupied by tiles of different types and orientations. The color of the tiles is chosen according to their orientation but we also consider defected regions which are not covered by the correct square-triangle tiling (white areas) and tiles with ambiguous orientations or misaligned with the dominant set of bond directions (yellow areas). Results are obtained with a 5.3 × 1010 collision-long simulation. Credit: *arXiv* (2023). DOI: 10.48550/arxiv.2307.01643

A team of physicists at Université Paris-Saclay has, for the first time, observed spontaneous quasi-crystal self-assembly. The observation occurred during an experiment they were conducting with tiny vibrating magnetic spheres. The team has written a paper describing their experiment and have posted it on the *arXiv* preprint server while they await peer review.

For many years, the existence of quasi-crystals was debated among physicists, with most arguing against them. But then, back in 1982 D. Shechtman and colleagues studying a sample of an alloy made of manganese and aluminum found it had characteristics that fit with the theorized proposed quasi-crystal—a diffraction pattern with Bragg peaks that were symmetrical—eliminating the possibility of it being a crystal.

Since that time, many examples of quasi-crystals have been found. They are now defined as aperiodic structures with some crystallographic properties. They have been seen in the lab, in the field, and even in space but until this recent work, they had never been seen forming spontaneously.

The work by the research team started when they began tossing around the idea of two groups of spheres related by ratio size as possible building blocks for a quasi-crystal and then took sides regarding its viability—they even made bets with some suggesting the idea would never work.

To prove one side right and the other wrong, the group developed a way to test the idea. First, they used computer simulations to find the right size spheres. Next, they obtained two groups of spheres, both of which were made of metal. One group had a diameter of 2.4 millimeters, the other 1.2 mm. They than placed all 3,840 spheres in a flat shallow pan and attached it to a device that would provide constant vibration for a long period of time. A recording microscope was fixed in place overhead. The pan was vibrated at 120 times per second for approximately one week.

After the jostling, the researchers looked at the arrangement of the spheres and found that they had arranged themselves in certain, non-repeating patterns which conformed to theory—the spheres had become a new kind of quasi-crystal. What is still not clear is which team members won the bet and what if anything did they receive as payout.

More information: Andrea Plati et al, Quasi-crystalline order in vibrated granular matter, *arXiv* (2023). DOI: 10.48550/arxiv.2307.01643