In a bowl of breakfast cereal, principles of attraction on display

May 17 2013

Credit: AI-generated image (disclaimer)

Andong He saw a phenomenon at work in his breakfast bowl that he couldn't explain. It prompted this question: How does cereal shape influence the way cereals floating in the milk join?

The Yale postdoctoral student offers an answer, along with collaborators

Khoi Nguyen and Shreyas Mandre of Brown University, in a new paper published May 14 in *Europhysics Letters*.

"Two floating objects, when they attract each other, will try to maximize the area of contact," said He, of Yale's Department of Geology & Geophysics. "Think about two ellipses—instead of tip to tip, they will try to align so that they are side to side."

The main reason for this tendency is that floating objects (pieces of cereal, for example) experience the so-called capillary force, which emerges from the natural attraction of a liquid's molecules to the molecules of an adjacent solid. A lone object afloat on an infinite surface will not move, because the total force is zero. But when there are several objects in the liquid, a net force acting on each causes them to move and ultimately join.

As the capillary force brings objects together, the associated torque further tends to maximize contact by rotating the objects, although rotating is not the only way. "If the objects are smooth enough, they can slide along each other," said He. "But the overall trend is always to decrease the gap between the objects, maximizing shared surface area as much as possible."

In an experiment, the authors used thin plastic sheets, with and without polished edges, and observed rotating and sliding motion.

The results could help explain patterns formed by a wide variety of floating objects, including micrometer-sized colloidal particles, aquatic plant seeds, and water striders.

The Yale-Brown team also worked out the fundamental principle of attraction in a new regime—that is, when floating objects are very close to each other. This could serve as a conceptual basis for addressing problems in materials processing and microelectronics, such as self-assembly of objects by flotation and geometrically controlled coagulation.

The researchers detail their theory and experiment in the paper, "Capillary interactions between nearby interfacial objects."

Said He, "You will never think of your breakfast in the same way again."

Brown University and The Nordic Institute for Theoretical Physics provided support for the research.

More information: iopscience.iop.org/0295-5075/102/3/38001

Provided by Yale University