Physicists develop potent packing process

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New York University physicists have developed a method for packing microscopic spheres that could lead to improvements in commercial products ranging from pharmaceutical lotions to ice cream. Their work, which relies on an innovative application of statistical mechanics, appears in the *Proceedings of the National Academy of Sciences*.

The study aimed to manipulate the properties of emulsions, which are a mixture of two or more immiscible liquids. The NYU researchers examined droplets of oil in water, which form the basis of a range of consumer products, including butter, ice cream, and milk.

The research was conducted in the laboratory of Jasna Brujic, an assistant professor in NYU's Department of Physics and part of its Center for Soft Matter Research.

Previously, her laboratory determined how spheres pack. These earlier findings showed how this process depends on the relative sphere sizes. In the *PNAS* study, Brujić and her research team sought to create a method to manipulate further how particles pack.

To do so, the researchers relied on a physical property known as "depletion attraction," a force that causes big particles to stick together by the pressure from the surrounding small ones.

Previous research has employed this process of attraction to create particulate gels, but these studies have tended to rely on thermally activated particles—below one micron in size—that result in complex structures known as fractals that look similar on all length scales.

In the PNAS study, the researchers used larger particles, which are not sensitive to room temperature and therefore pack under gravity alone.

To bring about depletion attraction, they added tiny polymers to the larger particles suspended in water. In essence, they used the smaller polymers to force together the larger spheres. In order to regulate the nature of this packing—how tightly or loosely the larger particles fit together—the researchers developed a statistical model that determines the fluctuations in the local properties of the packing.

"What we discovered is that you can control the connectivity of the particles—how they stick together and their properties—by manipulating the extent of the attraction," explained Brujić.

As a result of the discovery, the researchers have developed a method for potentially creating a range of materials—from loose to dense—based on the packing of their component parts.

Provided by New York University