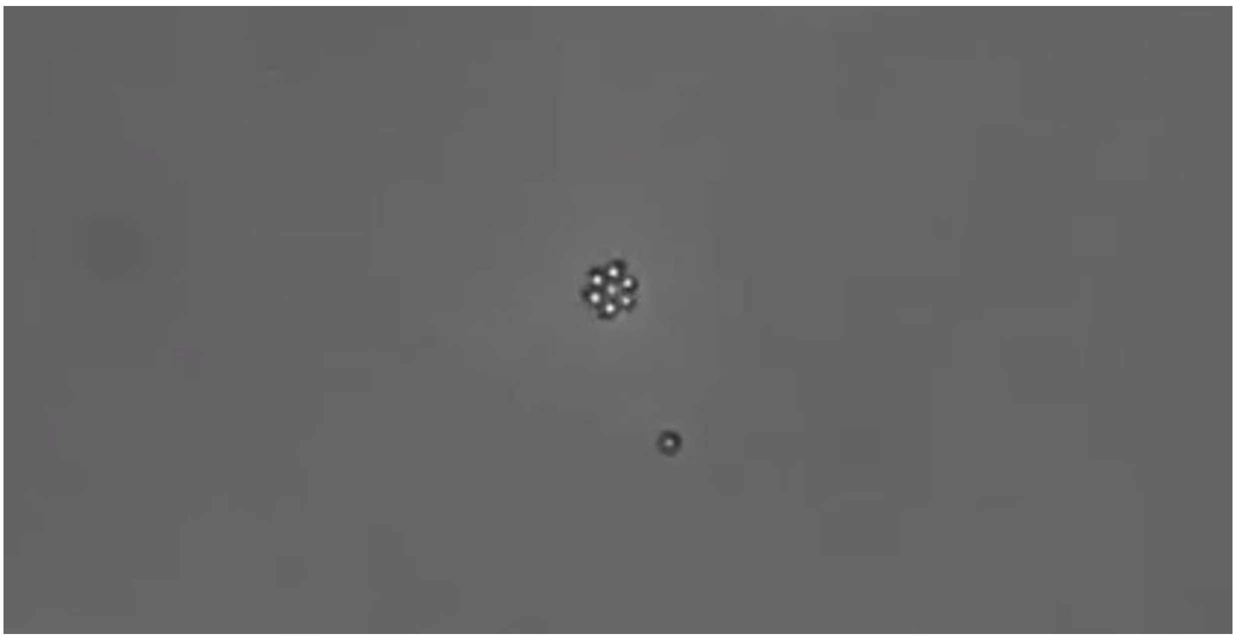
Scientists introduce new way to mimic 'machine of machines'

July 24 2018



Like small-scale Legos clicking into place, nature autonomously puts together microscopic building blocks. Living systems are biochemical machines that excel at building and moving their parts. Just as machines need energy in some form to operate, living systems are energized by consuming "fuel"—substances or food—reliably. The human body, for example, contracts muscles by the motion of tiny nanomotors—molecular devices that convert energy at the nanoscale

scale to generate movement at the macroscale. The ability to mimic nature's self-assembly would revolutionize science's approach to synthesizing materials that could heal, contract or reconfigure.

To explore this potential mimicry, University of California San Diego Assistant Professor of Physics Jeremie Palacci and postdoctoral scholar Antoine Aubret, together with Professor Stefano Sacanna and his team at New York University, introduced a new approach to assemble specially designed microscopic blocks into small gear-like machines. Their research results are outlined in a paper titled, "Targeted Assembly and Synchronization of Self-Spinning Microgears," published July 23 online in *Nature Physics*.

"This is a first important step in what we can build synthetically to emulate living systems," noted Palacci.

The building blocks are self-powered microparticles that propel after being activated by light. The scientists specially designed them to autonomously sense light gradients and navigate in light patterns. This leads to their remarkable assembly into only one type of machine—a self-forming, spinning microgear comprised of seven such microparticles—a "machine made of machines."

As a soft condensed matter, experimental physicist Palacci said that the team assembled the microgears into more sophisticated motifs and bigger machines, synchronizing like mechanical gears, even though they are not in contact.

"This is not magic, obviously, but physics," said Palacci. "The gears feel each other and interact through the fuel they consume and the liquid they move."

Aubret said that it was exciting to see what could be done in terms of self-assembly using two simple ingredients: light cues and a well-designed building block.

"Instead of picking the particles one by one, we just superimposed light patterns with our optical setup, and let the particles and rotors do the job," he explained. "Of course, it has been a lot of work to get here, but this is just the beginning of the story. It opens up new avenues for our research, and we hope that we can climb up even further in the hierarchy of self-assembling processes."

According to Germano Iannacchione, NSF program director who oversaw Palacci's grant, the goal of soft-matter research is not only to understand the fundamental principles that govern this vibrant and diverse field of science, but also to translate these principles into means of controlling matter in new ways.

"The exciting part of this work is the discovery of how to control and assemble small particles into larger, designed structures that can then be manipulated using light. This research is a beautiful example of making a tiny proto-machine that you never even touch," said Iannacchione.

More information: Antoine Aubret et al. Targeted assembly and synchronization of self-spinning microgears, *Nature Physics* (2018). DOI: 10.1038/s41567-018-0227-4

Provided by University of California - San Diego