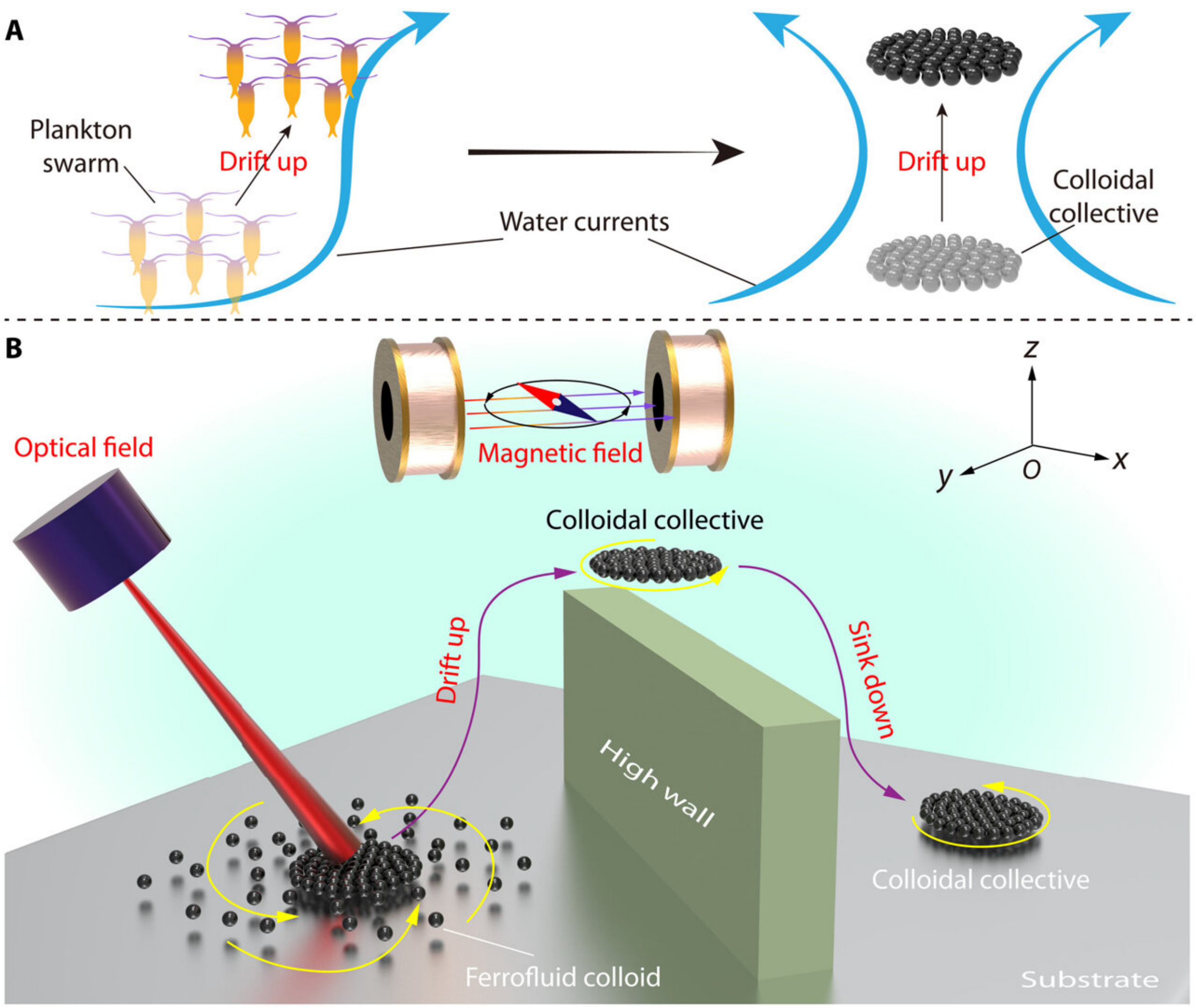
Bioinspired self-assembled colloidal collectives of active matter systems

November 23 2023, by Thamarasee Jeewandara



Three-dimensional drifting control of magnetic colloidal collectives. (A) The schematic diagram shows the motion mechanism of natural plankton. (B) The schematic diagram shows the colloidal collective climbing across a high obstacle under bimodal actuation fields (magnetic and optical fields). First, driven by the tailored rotating magnetic field, the settled ferrofluidic colloids self-assemble into a dynamic stable colloidal collective. Second, the optical field stimulates the colloidal collective to generate convective flow through the photothermal effect, thus allowing the colloidal collective to use currents for 3D drifting motion like the plankton. The proposed colloidal collectives can propel themselves in 3D space, transit between air-water surfaces, and move on the water surface. Credit: *Science Advances*, doi: 10.1126/sciadv.adj4201

Active matter systems feature unique behaviors that include collective self-assembly structures and collective migration. However, the efforts to realize collective entities in spaces without wall-adhered support, in order to conduct three-dimensional locomotion without dispersion, are challenging.

In a new study, published in *Science Advances*, Mengmeng Sun and a research team in mechanical engineering and physical intelligence in China and Germany, were bioinspired by migration mechanisms of plankton and proposed a bimodal actuation strategy by combining magnetic and optical fields.

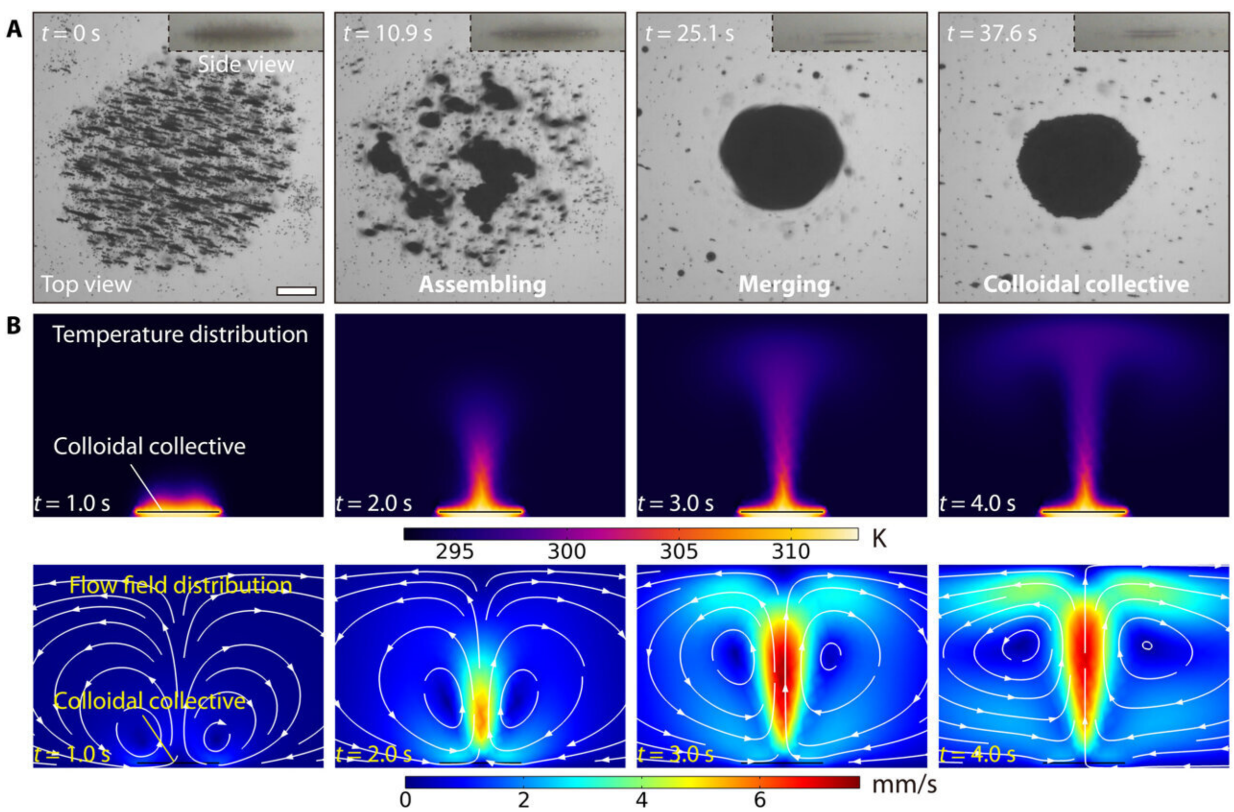
While the magnetic field triggered the self-assembly of magnetic colloidal particles to maintain numerous colloids as a dynamically stable entity, the optical fields allowed the colloidal collectives to generate convective flow through photothermal effects for 3D drifting. The collectives performed 3D locomotion underwater to provide insights into the design of smart devices and intelligent materials for synthetic active matter that can regulate collective movement in 3D space.

Active living matter

Active living matter is ubiquitous in nature, offering self-assembled collectives that can accomplish complex tasks that surpass individual capabilities, which include bird flocks, and colonies of bacteria.

Bioinspired by natural collectives, it is possible to examine colloids as building blocks for materials, much like atoms that form building blocks of molecules and crystals. Colloidal self-assembly can be studied as a method to fabricate nanostructures with technical implications to build nanoscale electronics, energy conversion or storage, drug delivery and catalysts.

The process of colloidal assembly can be guided on a patterned substrate or through Langmuir-Blodgett assembly, for assembly in fibers and cells, and as chemical signals.



Generation of the upward and downward movements of the colloidal collective.

(A) Dispersed colloids (

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