Study shows precise control of colloids through magnetism is possible

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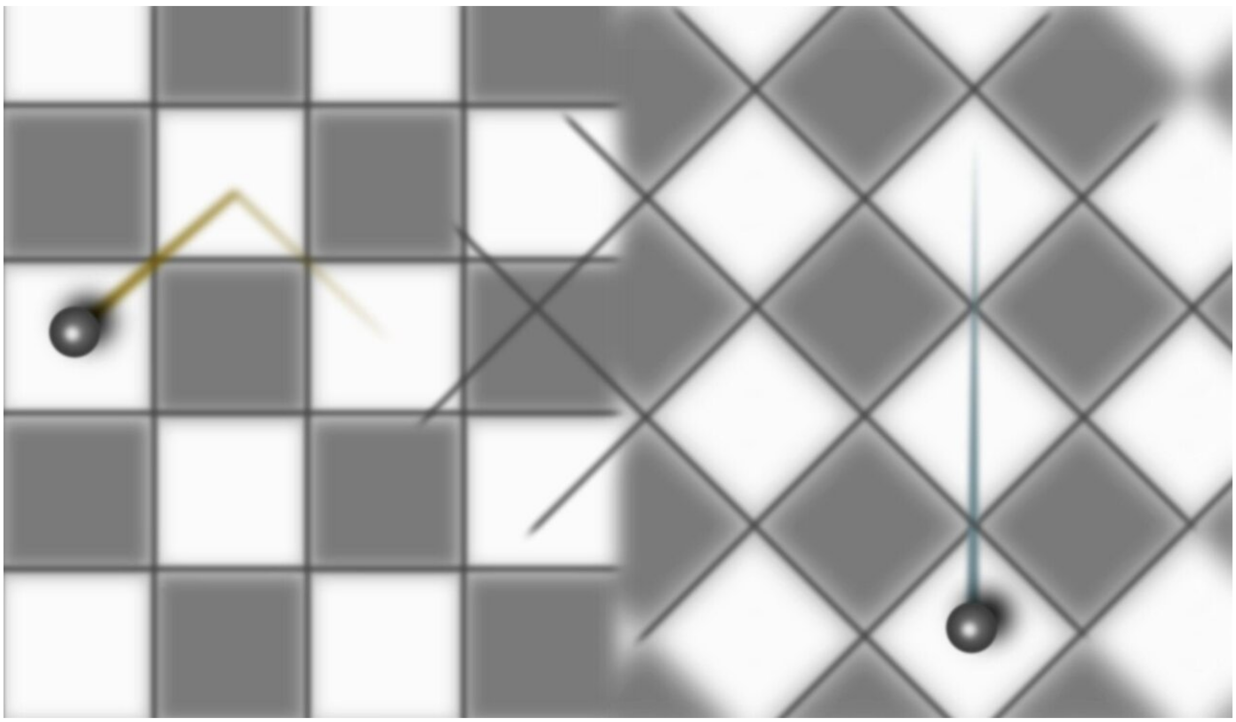

Visualisation of magnetic controlled colloids. Credit: Bayreuth University

Bayreuth researchers have found ways to control tiny particles in liquids using magnetic patterns. The research results have now been published in *Nature Communications* under the title "Simultaneous and independent topological control of identical microparticles in non-periodic energy landscapes."

Overall, the simultaneous and independent transport of colloidal particles over magnetic patterns can be of great use in various fields of science and technology to produce customized materials, improve biomedical applications, perform laboratory tests or investigate fundamental scientific questions.

In this theoretical and experimental work, Nico C.X. Stuhlmüller and Prof Dr. Daniel de las Heras (theory) together with Farzaneh Farrokhzad and Prof Dr. Thomas Fischer (experiments) investigated the simultaneous and independent transport of identical colloidal particles (nano- to micrometer-sized particles suspended in a liquid) over magnetic patterns.

External fields, such as electric and magnetic fields, are often used to transport a collection of colloidal particles. Identical particles are then transported along the same direction under the influence of the field. The scientists demonstrate here that using non-periodic energy landscapes it is possible to precisely control the transport of a collection of identical colloidal particles simultaneously and independently.

Magnetic microparticles are placed above a magnetic pattern. The pattern is made with up- and down-magnetized regions arranged differently depending on the position over the pattern. The transport is then driven by modulation loops of the orientation of an external magnetic field. A complex time-dependent and non-periodic energy landscape emerges due to the coupling between the external magnetic field and the field created by the pattern.

Arbitrarily complex and tailored trajectories of several identical colloidal particles can be simultaneously encoded in either the pattern or the modulation loops. As an illustration, the scientists show how identical colloidal particles under the influence of the same modulation loop can write the first 18 letters of the alphabet.

Beyond its fundamental interest, this work opens new routes to reconfigurable self-assembly in colloidal science and has potential applications in multifunctional lab-on-a-chip devices. A precise and simultaneous targeted control of colloidal particles using magnetic fields can be used for example to develop microfluidic systems that transport particles for laboratory testing and medical diagnosis.

More information: Nico C. X. Stuhlmüller et al, Simultaneous and independent topological control of identical microparticles in non-periodic energy landscapes, *Nature Communications* (2023). DOI: 10.1038/s41467-023-43390-0

Provided by Bayreuth University

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