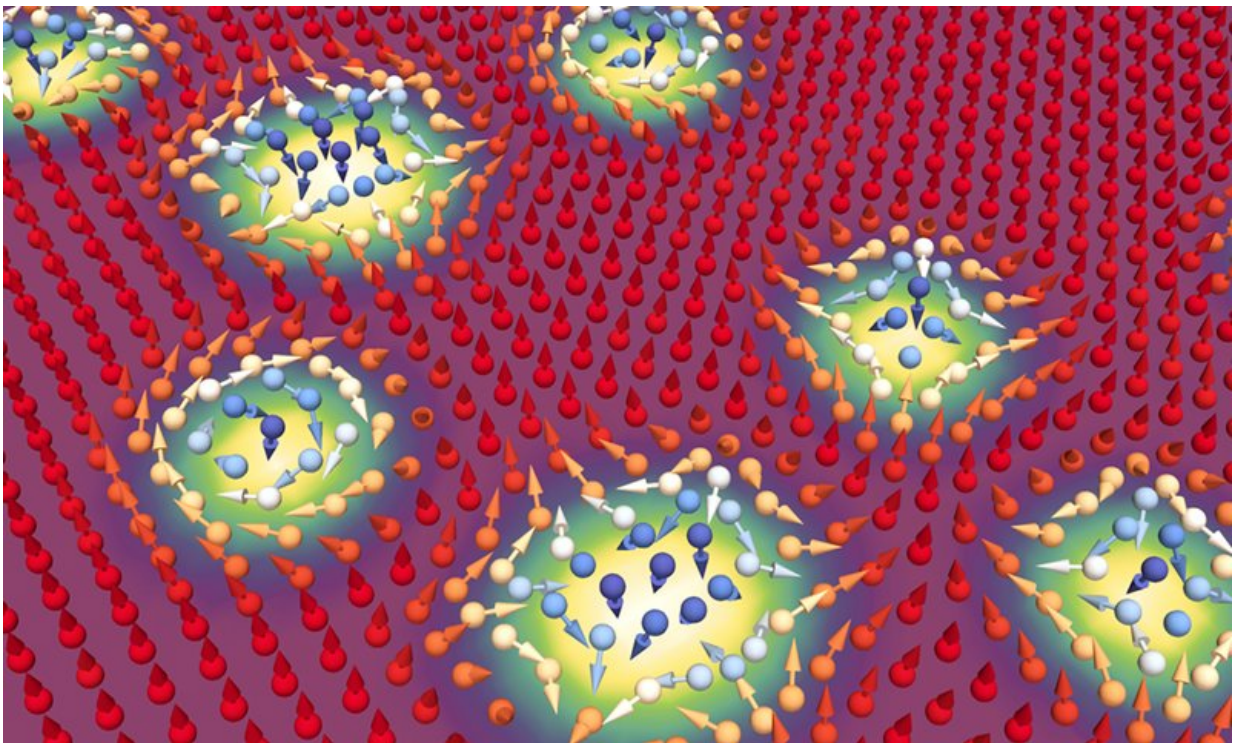


Frustrated magnetic skyrmions and antiskyrmions could enable novel spintronic applications

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Skyrmions and antiskyrmions with different topological numbers in a frustrated magnet. Credit: Xichao Zhang

The 2016 Nobel Prize in Physics was awarded to three theoretical physicists for their discoveries of topological phase transitions and

topological phases of matter, which highlights the role and significance of topology in understanding the physical world. In the field of magnetism, topology is also directly related and fundamental to the physics of an exotic magnetic texture, the magnetic skyrmion.

Magnetic skyrmions are nanoscale magnetic structures with topological quantum numbers, which exist in a number of materials and can be controlled by methods such as electric current and others. Due to their nanoscale size and topologically protected stability, [magnetic skyrmions](#) hold great promise in spintronic applications such as magnetic memory and logic computing devices. In order to manipulate magnetic skyrmions for information processing, it is essential to fully understand their dynamics.

Recently, a team of researchers from China and Japan has studied the magnetic skyrmions in frustrated magnets and revealed the exotic dynamics of frustrated magnetic skyrmions, which is totally different from that of magnetic skyrmions in common ferromagnetic materials. They found the helicity locking-unlocking transition of frustrated magnetic skyrmions by including dipole-dipole interactions in their theoretical model, which is an energy term usually negligible for common ferromagnetic skyrmions. In the frustrated magnets, the dipole-dipole interaction plays an important role in the helicity (rotational mode)-orbit (translational mode) coupling of the skyrmion, especially at low temperature. In addition, the researchers show that the current-controlled skyrmions and antiskyrmions dynamics with locking-unlocking helicity in frustrated magnets can enable novel spintronic applications such as the helicity-based information storage devices.

The discovery are reported this week in the journal *Nature Communications*, in a paper by the Chinese University of Hong Kong, Shenzhen researcher Xichao Zhang, and PhD student Jing Xia, and four others from Shenzhen University, China, Shinshu University, Japan, and

the University of Tokyo, Japan.

"Helicity is a degree of freedom of frustrated magnetic skyrmions," says Xichao Zhang, a researcher at the Chinese University of Hong Kong, Shenzhen, and the first author of the study. "In conventional ferromagnetic materials, the helicity of a skyrmion cannot be effectively controlled, while we find it is possible to control the [skyrmion](#) helicity by utilizing the helicity locking-unlocking transition in frustrated magnetic materials." Zhang adds that the control of helicity can lead to novel spintronic applications such as the helicity-based skyrmionic memories.

"Our study also shows the interactions between frustrated skyrmions and antiskyrmions, which are problems of both theoretical and practical significance," explains Yan Zhou, associate professor of the Chinese University of Hong Kong, Shenzhen, and the corresponding author of the study. Zhou says it is also possible to build logic computing devices based on skyrmions and antiskyrmions, and his group is pursuing this currently.

"We can use frustrated skyrmions as a binary memory utilizing two stable Bloch-type states, where the helicity can be switched by applying current," says Motohiko Ezawa, lecturer of the University of Tokyo, and the other corresponding author of the study.

More information: Zhang, X. et al. Skyrmion dynamics in a frustrated ferromagnetic film and current-induced helicity locking-unlocking transition, *Nature Communications* 8, 1717 (2017). [DOI: 10.1038/s41467-017-01785-w](https://doi.org/10.1038/s41467-017-01785-w)

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