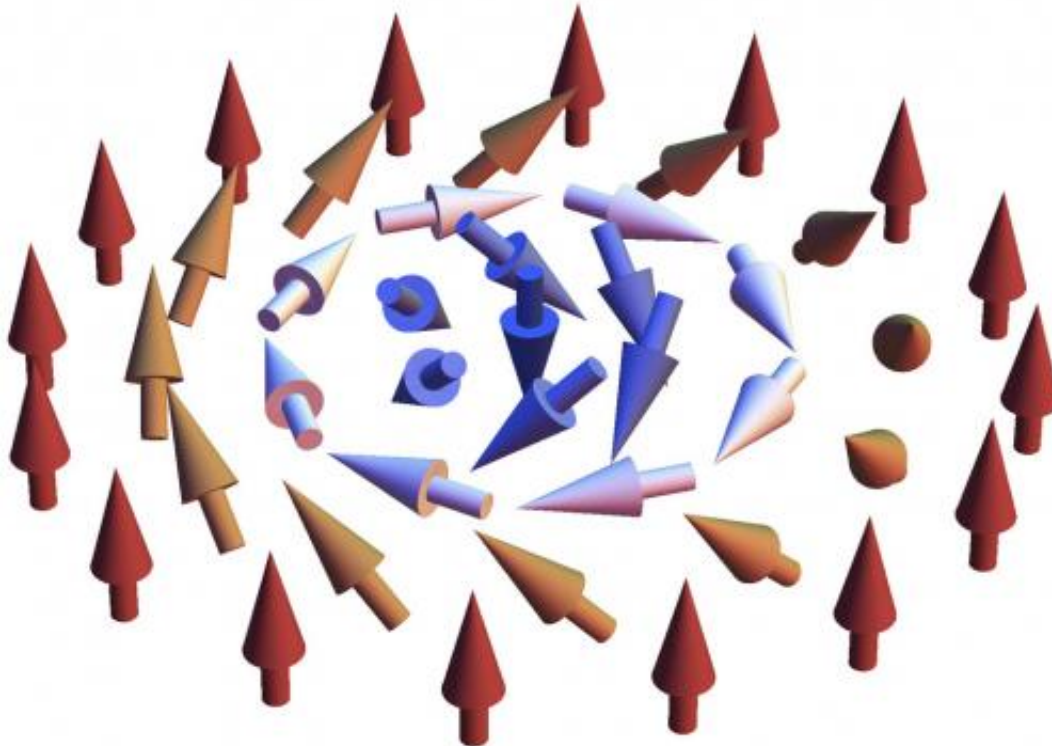


# Magnetic vortices with electric sense

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An artistic representation of a magnetic vortex. In magnetic materials, spins—represented here as arrows—can adopt arrangements such as the skyrmion structure shown above that are robust against external perturbations. Reproduced, with permission, © 2012 AAAS

In the field of magnetic materials, a rapidly expanding area of study concerns stable nanometer-scale spin arrangements. Spins are the fundamental magnetic entities in solids, and patterns made of several spins could be useful components in applications such as memory

devices. Applied physicist Shinichiro Seki and his team in Japan, including members from the RIKEN Advanced Science Institute, Wako, now report the observation of one such spin pattern, called a ‘skyrmion’, in a material where it can be manipulated with electrical fields. This finding could help to make future devices based on spin structures more energy-efficient.

Skyrmions are magnetic structures in which spins adopt a vortex pattern. They are a famed example of [spin](#) textures that are, by virtue of their specific spatial arrangements, robust against external perturbations. This robustness is important for device applications. Also, skyrmions are only tens of nanometers in diameter, making them promising candidates for use in compact electronic components.

In the past few years, scientists have observed skyrmions in a range of metals, which are conducting materials. Now, Seki and his colleagues have detected skyrmions in an insulating material,  $\text{Cu}_2\text{OSeO}_3$ . In addition to being non-conductive,  $\text{Cu}_2\text{OSeO}_3$  has another important property: the spins—that is, the elementary magnetic units—are ordered in well-defined patterns as are their electric counterparts. “Materials with both magnetic and electric order are called multiferroics,” explains Seki. “For  $\text{Cu}_2\text{OSeO}_3$ , emergence of electric ordering has now been reported for the first time.”

The coupling of [magnetic](#) and electric order in this material has important ramifications. “Our analysis suggests that each skyrmion can carry some form of electric order, which implies that the dynamics of skyrmions is controllable through external electric fields,” says Seki. This kind of skyrmion manipulation is not possible in conducting materials, where electric fields cause electrons to flow, which in turn leads to detrimental heating effects.

Progress in this field is fast. In recent weeks, further evidence has been

reported that skyrmions induce electric order, and additional experiments and analysis by Seki and colleagues, supported by theoretical work by collaborators in China and the United States, helped in identifying the microscopic origin of magnetoelectric coupling in  $\text{Cu}_2\text{OSeO}_3$ .

In light of these findings, Seki expects that other insulating materials may host skyrmions or related spin arrangements. “Recent theories predict that skyrmions may appear in a broad class of [magnetic materials](#),” he says. “We therefore strongly expect further discoveries of various types of spin structures with unique magnetoelectric properties.”

**More information:** Seki, S., Yu, X. Z., Ishiwata, S. & Tokura, Y. Observation of skyrmions in a multiferroic material. *Science* 336, 198–201 (2012). [DOI: 10.1126/science.1214143](https://doi.org/10.1126/science.1214143)

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Provided by RIKEN

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