Bimeronium: A new member of the topological spin textures family

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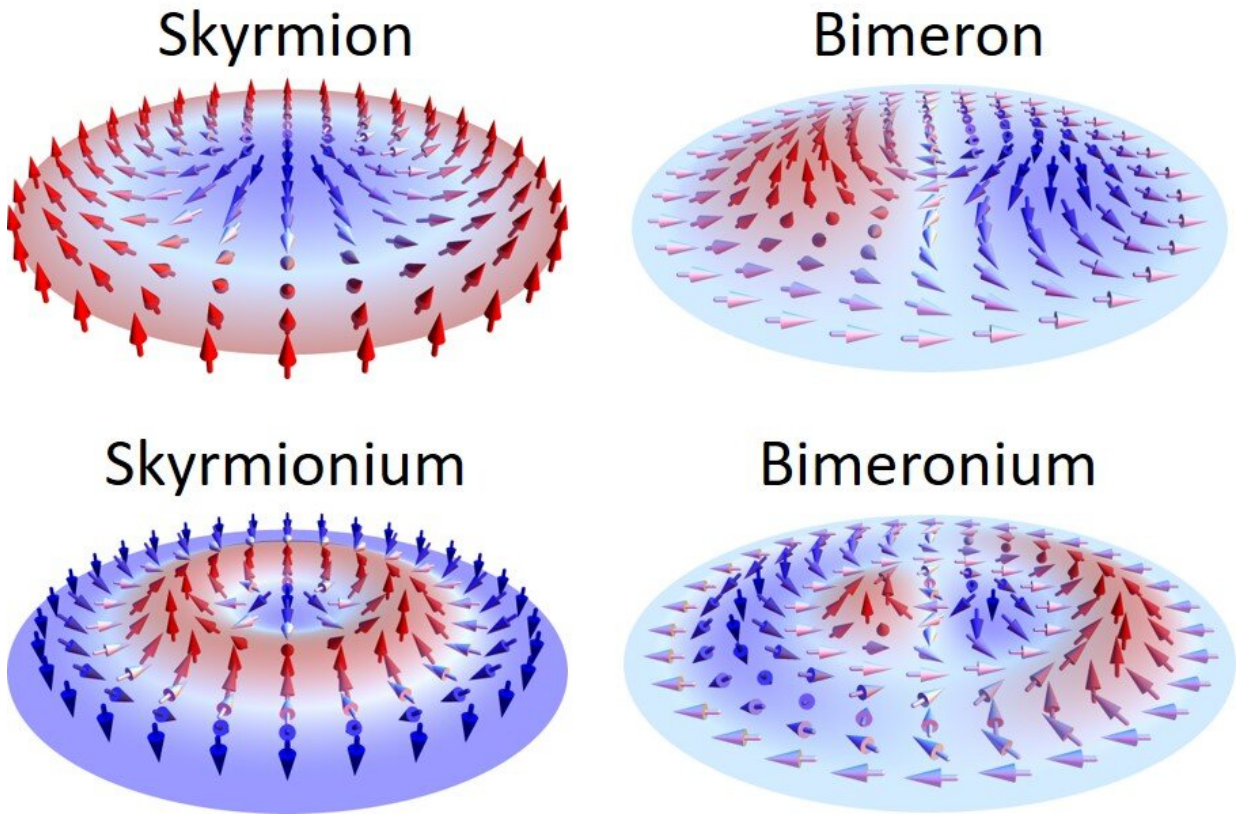

Credit: Xichao Zhang (2020).

Topological spin textures in magnetic systems are intriguing objects that exhibit exotic physics and have potential applications in information storage and processing. The most fundamental and exemplary

topological spin texture is called the skyrmion, which is a nanoscale circular domain wall carrying a nonzero integer topological charge. The skyrmion texture in magnetic materials was theoretically predicted in the late 1980s, and it was experimentally observed in chiral magnets a decade ago. Since the first observation of magnetic skyrmions, the skyrmion community has focused on a series of topological spin textures evolved from the skyrmion, such as the skyrmionium and bimeron.

In a recent theoretical work carried out by an international team from China, Japan, Australia, Russia, and France. The authors introduced a new type of topological spin textures, which is called the bimeronium. The bimeronium exists in magnets with in-plane magnetization. It is a topological counterpart of skyrmionium in perpendicularly magnetized magnets and can be seen as a combination of two bimerons with opposite topological charges. Therefore, the bimeronium carries a topological charge of zero, like the skyrmionium.

The authors studied the bimeronium stabilized in a magnetic monolayer with frustrated exchange interactions. They found that the frustrated bimeronium can be driven into steady self-rotation by the damping-like spin-orbit torque at certain conditions. This study suggests that the bimeronium has the possibility to be controlled by external stimuli, which means it could be used as a spintronic building block.

The results have been published online on 3 February in the journal *Applied Physics Letters*, in a Letter by Prof. Yan Zhou's group from The Chinese University of Hong Kong, Shenzhen (CUHKSZ), and several collaborators from Sichuan Normal University, China, The University of Tokyo, Japan, The University of New South Wales, Australia, National University of Science and Technology, Russia, CY Cergy Paris University, France, and Shinshu University, Japan

"A number of different types of topological spin textures can be found

in frustrated spin systems in principle," says Dr. Xichao Zhang, a researcher currently at Shinshu University, and the first author of the study. "Skyrmions and skyrmioniums have been extensively investigated for many years, now I think it's the time to explore their counterparts in different magnetic systems. In the future, different topological spin textures may play different roles in spintronic applications."

"Recently, magnetic systems with in-plane anisotropy regaining interest, so it is important to understand the dynamic properties of topological spin textures such as bimerons and bimeroniums, which may lead to novel spintronic applications," explains Dr. Oleg A. Tretiakov, senior lecturer at the University of New South Wales, and the co-author of this study.

"In fact all of those fascinating new magnetic discoveries come from competing interactions in frustrated spin systems. The frustration is at the origin of many new phenomena discovered since the 80's and many of them are still to be discovered in the time to come," says Dr. Hung T. Diep, distinguished professor at CY Cergy Paris University, and the co-author of this study.

"In theory, the bimeronium can also be stabilized by chiral exchange interactions in ferromagnets and antiferromagnets. We believe it is possible to observe these novel topological objects in magnetic materials using existing methods," explains Dr. Yan Zhou, associate professor at CUHKSZ, and the corresponding author of the study.

More information: Xichao Zhang et al. A frustrated bimeronium: Static structure and dynamics, *Applied Physics Letters* (2021). DOI: 10.1063/5.0034396