Harness the Power of Quantum Technology: Taming Topological Magnetic Textures

In the uprising quantum era of the 21st century, the application of quantum technology is becoming one of the forefronts in modern quantum research and the next generation information industry. HKU theoretical physicist, Dr. Gang Chen, recently proposed a novel method to tame the topological magnetic textures in a magnetic-ferroelectric heterostructure that was originally designed by the research team, led by HKU chancellor Professor Xiang Zhang. The topological magnetic texture was known as magnetic skyrmion. This topologically robust object was believed to be ideal for information storage and processing, and thus could serve as a potential building block for the device fabrications.

In the original design by Professor Zhang et al (*Nature Communications,* **10,** 2657), a single-atomic sheet of magnet $Cr_2Ge_2Te_6$ is stacked on a sheet of ferroelectric In_2Se_3. Such an ingenious design leads to the atomic multiferroicity with switchable ferromagnet and magnetic semiconductor. Dr. Chen's group studied this material and realized the emergence of magnetic skyrmions. With the electric and magnetic controllability in the original design, it was realized that this topological object can be written and/or deleted with electric fields. This opens doors to the electric control of magnetic skyrmions.

The microscopic mechanism is rooted in Dzyaloshinskii-Moriya interaction that can emerge from the ferroelectricity. This interaction was originally put forward by Soviet physicist Dzyaloshinskii and Japanese physicist Moriya, and is realized from the combination of quantum mechanics and Einstein's special theory of relativity, the two milestones in 20th century physics. With the Dzyaloshinskii-Moriya interaction, the electron spins no longer align parallel to each other, but find it more comfortable to lie at an angle with each other. At last, a skyrmion texture is formed. The microscopic density-functional theory and the coarse-grained Ginzburg-Landau theory were combined to demonstrate these novel results.

This study was featured as a letter in Phys Rev Research, and was performed at the HKU Physics Department and Faculty of Sciences. HKU postdoctoral fellow Dr. Chaokai Li and HKU postgraduate Xu-Ping Yao contributed to this work under Dr. Chen's supervision (Phys Rev Research, 3, L012026).

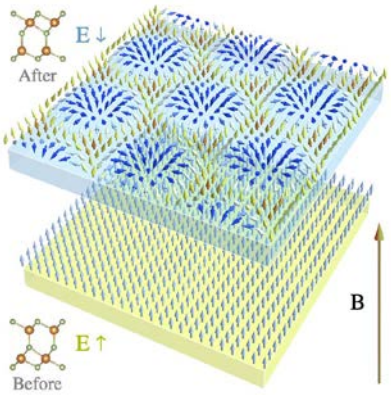

Image: The electric control of magnetic skyrmions (figure credit: HKU postgraduate Xu-Ping Yao).