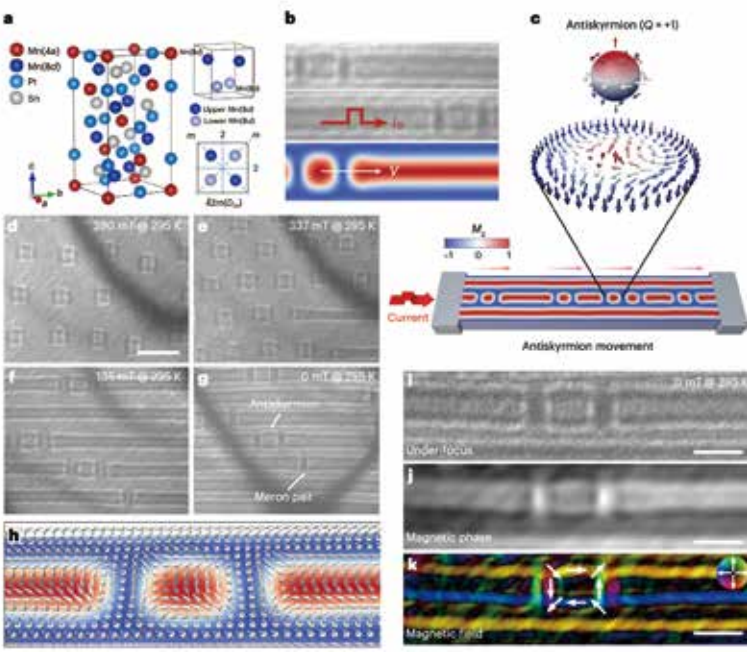
Experimental Observation of Current-driven Antiskyrmion Sliding

Prof. ZHANG Ying's group at the Institute of Physics (IOP), Chinese Academy of Sciences (CAS) has teamed up with researchers from domestic universities and the Alamos National Laboratory in the United States to succeed in observing current-driven antiskyrmion sliding in experiment, and published their work entitled "Experimental observation of current-driven antiskyrmion sliding in stripe domains" was published in *Nature Materials* on April 11, 2023.

The magnetic (anti)skyrmions with topologically protected spin structures are promising as next-generation information units in spintronic devices. The ability to transport (anti)skyrmions using electric currents is particularly interesting for high-efficiency data storage and process. However, the big challenges lie in the undesired lateral deflection towards the sample edge and the eventual annihilation due to the magnus force from (anti)skyrmion hall effects. Moreover, despite the abundant skyrmion progress, the current-driven movement of antiskyrmions has not been experimentally realized yet.

Under the consistent support from Academician SHEN Baogen, Prof. ZHANG Ying's team has established a specialized magnetization characterization platform with Focused Ion Beam Microscopy, Lorentz Transmission Electron Microscopy (L-TEM) and multiple *in-situ* holders *et al.* The platform is powerful for directly studying the topological domains with ultra-high spatial resolution under different external fields. The work team has system-



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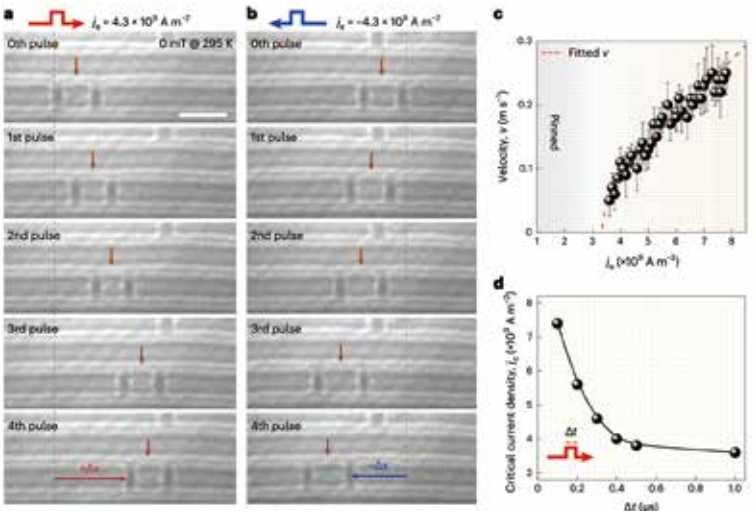
Realization of room-temperature antiskyrmions with different magnetization states and their straight current-driven behaviour along the naturally helical stripes at zero field.



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Influence of electric current direction, density and pulse period on the antiskyrmion sliding along the straight stripe domain.

atically studied the skyrmion generation and manipulation in many kinds of materials and accumulated rich experiences.

This time, the researchers have successfully demonstrated the straight sliding dynamics of antiskyrmions driven by electric currents at room temperature and without the presence of any external magnetic field in $Mn_{1.4}PtSn$ chiral magnet. This achievement is realized by embedding antiskyrmions within strongly correlated helical stripe domains in contrast to the common manipulation of topological skyrmions in the ferromagnetic background. These stripe domains provide naturally one-dimensional linear tracks, along which antiskyrmion sliding is launched at low current densities without transverse deflection from the antiskyrmion Hall effect. The higher mobility of antiskyrmions within the helical stripe background can be well understood through micromagnetic simulations and collective pinning theory, thereby easily smearing out random pinning potentials. Furthermore, this method can be extended to the sliding motion of merons or skyrmions in stripe domains, further demonstrating its general applicability.

Thus, the demonstration and comprehensive understanding of antiskyrmion movement along naturally straight tracks at low current densities in conquer of deflection under a wide temperature range and zero magnetic field offers a new perspective for (anti) skyrmion application in spintronics.

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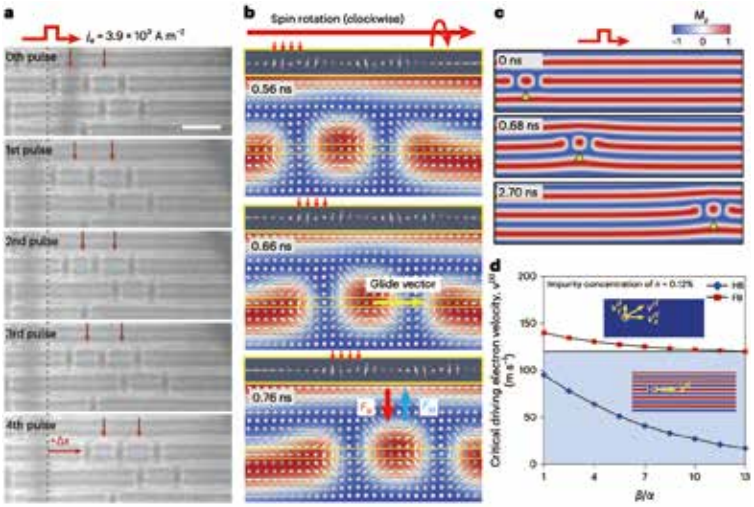

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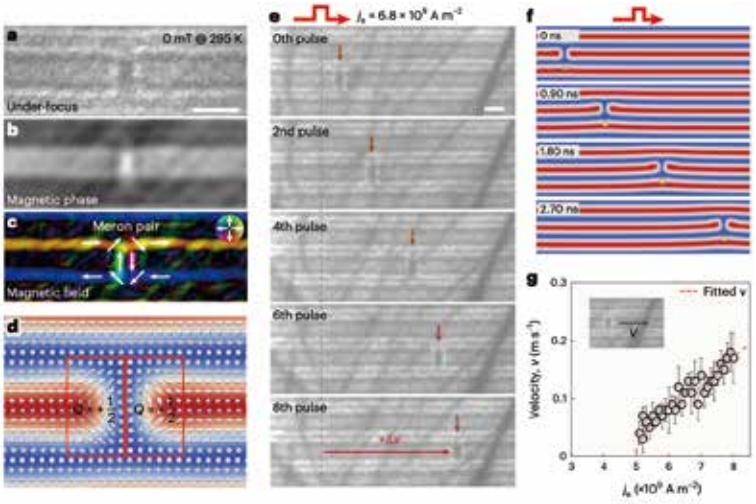
Mechanism of antiskyrmion sliding along stripe domains in comparison with ferromagnetic background.



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Room-temperature merons sliding in stripe domains at zero field.

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