A collaboration between Fudan University (Shanghai – China) and CNR-SPIN (L'Aquila) reveals a spin-texture which is tunable by antiferromagnetic order parameter.

ACTIVITY C Innovative materials with strong interplay of spin orbital charge and topological degrees of freedom-2020

Tunable spin textures in polar antiferromagnetic hybrid organic-inorganic perovskites by electric and magnetic fields

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NPJ COMPUTATIONAL MATERIALS 6, 114 (2020)

The hybrid organic-inorganic perovskites (HOIPs) have attracted much attention for their potential applications as novel opto-electronic devices where the Rashba band-splitting, together with specific spin orientations in k-space (*i.e.* spin texture), has been found to be relevant for their performances. Here, we study the electric polarization, magnetism, and spin texture properties of the antiferromagnetic (AFM) HOIP ferroelectric TMCM-$MnCl_3$ (TMCM=$(CH_3)_3NCH_2Cl^+$, trimethylchloromethyl ammonium). This compound is ferroelectric with a large piezoelectric response, high ferroelectric transition temperature, and excellent photoluminescence properties [You *et al.*, Science 357, 306 (2017)]. The inversion symmetry breaking coupled to the spin-orbit coupling gives rise to a Rashba-like band-splitting and a related robust persistent spin texture (PST) and/or typical spiral spin texture, which can be manipulated by tuning the ferroelectric or, surprisingly, also by the AFM magnetic order parameter. The tunability of spin texture upon switching of AFM order parameter is largely unexplored and our findings not only provide a platform to understand the physics of AFM spin texture but also support the AFM HOIP ferroelectrics as a promising class of opto-electronic materials. [*npj Comput Mater* **6,** 114 (2020). https://doi.org/10.1038/s41524-020-00374-8]

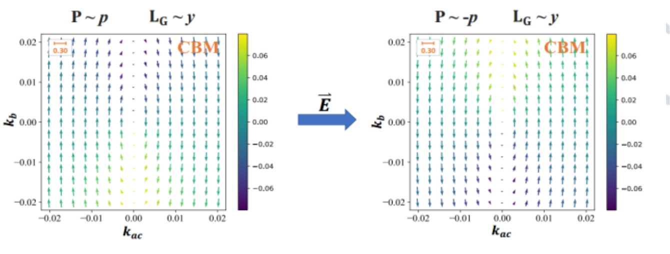

Fig 1 (Right). The interplay between electric polarization and spin textures in G-type AFM state. Here we show the spin textures at Conduction Band Maximum (CBM). $\mathbf{P}\sim\boldsymbol{p}$ ($\mathbf{P}\sim$ -$\boldsymbol{p}$) refers to polarization along $[10\bar{1}]$ ($[\bar{1}01]$), respectively. $\mathbf{L_G}$~$\boldsymbol{y}$ present G-type AFM state with spin moment along y axis. k_b and k_{ac} denote the k-path with the unit of Å^{-1}. The arrows refer to the in-plane orientation of spin mean-values and the scale is shown in the top left corner, while colors indicate the out-of-plane component. Under external electric field, the spin texture can be tuned.

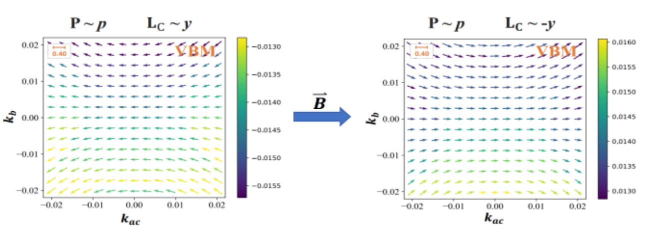

Fig 2 (Left). Interplay between magnetic ordering and spin textures at CBM in C-type AFM state. $\mathbf{P}\sim\boldsymbol{p}$ denotes polarization along $[10\bar{1}]$. $\mathbf{L_C}$~$\boldsymbol{y}$ ($\mathbf{L_C}$~-$\boldsymbol{y}$) present C-type AFM state with spin moment along y (-y) axis, respectively. k_b and k_{ac} denote the k path with the unit of Å^{-1}. The arrows refer to the in-plane orientation of spin mean-values and the scale is shown in the top left corner, while colors indicate the out-of-plane component. Under external magnetic field, the spin texture can be tuned.