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Novel properties due to crystal symmetry in spin-splitting antiferromagnet and topological superconductor

ABSTRACT

I will talk about the novel properties due to crystal symmetry spin-splitting antiferromagnets (AFMs) [Nat. Commun. 12, 2846 (2021)] (named as altermagnet in 2022) and in topological superconductor [Nature 633, 71 (2024)].

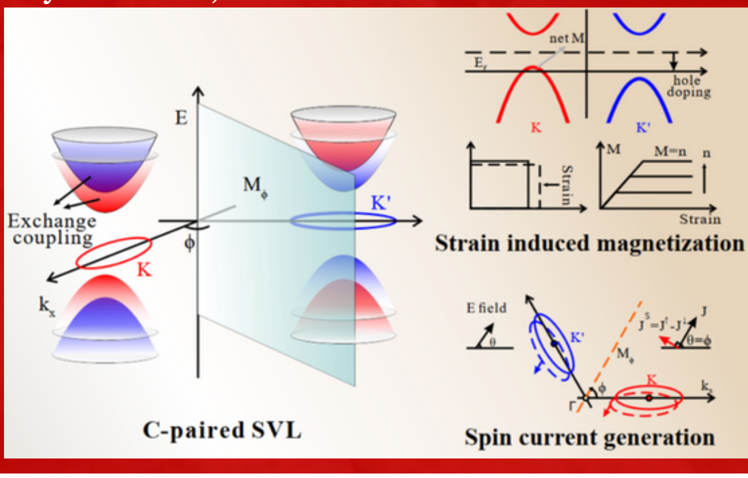
In spin-splitting AFMs, we propose the crystal-symmetry-paired spin-valley/momentum locking (CSVL/CSML), which is enabled by a crystal symmetry and intrinsically exists in AFMs (e.g., V_2Se_2O, V_2Te_2O, MnTe and RuO_2) [Nat. Commun. 12, 2846 (2021)]. CSML enables feasible controls of spin in AFMs by manipulating the corresponding crystal symmetry. Typically, one can use a strain field to induce net valley polarization/magnetization and use an electric field to generate a noncollinear spin current even without spin-orbit coupling. All the predictions have been confirmed in experiments [arXiv:2407.19555; arXiv:2408.00320]. These properties have helped us realize the electric readout and 180o deterministic switching of the Néel order in our experimental work in Mn_5Si_3 [Sci. Adv. 10, eadn0479 (2024)] and CrSb [arXiv:2403.07396 Nature (accepted)].

In topological superconductors, magnetic mirror symmetry can protect multiple Majorana zero modes (MZMs) in a single vortex, which allows feasible controls of hybridization of MZMs simply using an external field. This has been realized in our recent collaborative experimental works with Prof Jin-Feng Jia's group [Nature 633, 71 (2024); Quantum Frontiers 3, 20 (2024)]. Similar properties can also be realized in superconducting CSVL/CSML materials

BIO

Prof. Junwei Liu obtained his PhD at Tsinghua University in 2014 and then did his postdoctoral research at MIT. He joined HKUST in 2017 as an assistant professor and was promoted to an associate professor in 2023.

Prof. Liu has a broad interest in condensed matter physics and quantum physics, varying from the traditional phenomena like ferroelectricity to the exotic topological phases like quantum spin Hall insulators. His major contributions include (1) theoretical prediction of SnTe-type topological crystalline insulator, WTe2-type and TaIrTe4-type quantum spin Hall insulator; (2) discovery of world-first monolayer ferroelectricity in SnTe thin films; (3) proposal of self-learning Monte Carlo methods that can be thousands of times faster than conventional methods without loss of any accuracy; (4) design and realization of the world-first all-optical neural networks; and (5) proposal of crystal-symmetry-paired spin-valley locking and realization of world-first electrical readout and 180° switching of the Néel order in spin-splitting antiferromagnetic materials. He has published more than 60 papers including 2 in Science, 2 in Nature, 1 in Nat. Phys., 3 in Nat. Mater., 7 in Nat. Commun., 3 in Phys. Rev. Lett., etc



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