Spin- and angle-resolved photoemission studies on magnetic topological insulators

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$MnBi_{2n}Te_{3n+1}$ (MBT) compounds have been intensively studied in recent years as they constitute the first intrinsic bulk magnetic topological insulator family that has been synthesized. When time-reversal symmetry (TRS) is spontaneously broken, MBT has been shown to host exotic quantum phenomena such as the quantum anomalous Hall effect. However, despite the clear evidence of broken TRS, angle-resolved photoemission spectroscopy (ARPES) studies predominantly report a surface state exhibiting no gap in the magnetic phase, in contradiction to theory. Furthermore, the electronic structure of MBT remains poorly understood, which hinders research to exploit applications of its unique magnetic topological properties.

Here, we present an experimental methodology to tackle these problems by reconstructing the wavefunction of the $MnBi_2Te_4$ and $MnBi_4Te_7$ surface states using spin-resolved ARPES. We will first show the intricate spin-orbital texture of the surface states by systematically tracking the spin-polarization and orbital characters as a function of momentum. Then, we will introduce a wavefunction model that quantitatively describes the experimental data. Our results demonstrate that the surface states are well-described by a single-band picture dominated by *p* orbitals, solidifying the microscopic understanding of MBT. Most importantly, based on the methodology, we will present a novel intrinsic mechanism for reducing the magnetic gap of topological surface states, providing crucial insight into the long-standing puzzle of the gapless Dirac cone in the MBT material family.

REFERENCES

[1] **Xue Han**, Jason Qu, Hengxin Tan, Zicheng Tao, Noah M. Meyer, Patrick S. Kirchmann, Yanfeng Guo, Binghai Yan, Zhi-Xun Shen and Jonathan A. Sobota, *Phys. Rev. X* **15**, 031022 (2025).