Spectroscopic Discovery of Spin-split Antiferromagnets

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Manipulating the spin of electrons in space, momentum, and energy is the foundation and core of spintronics. Traditional spintronic devices use ferromagnets as generators and manipulators for spin currents. However, the information storage density of ferromagnetic materials is not high, and their read and write speeds are relatively slow (in the GHz range). On the contrary, the information storage density of antiferromagnetic materials can reach the atomic level, and their unique terahertz (THz) spin dynamics can also achieve magnetic moment reversal at the picosecond time scale. From this, it can be seen that ideal next-generation spintronic materials need to have the characteristics of ferromagnets that are easy to write and read information, as well as the ability of antiferromagnets to store information with high stability and density, and ultrafast spin dynamics properties. Recently, attention has been paid to a previously overlooked set of symmetric operations in magnetic materials at the limit of zero spin orbit coupling. These operations have led to the emergence of a new type of antiferromagnetic induced spin splitting, enabling the energy bands of antiferromagnets to achieve significant momentum dependent spin polarization [1-5]. The magnetic and electrical properties of this unconventional antiferromagnet are more similar to those of ferromagnets, thus combining the advantages of both ferromagnets and antiferromagnets, and it is expected to replace ferromagnets as the material foundation of spintronics. In this report, we will present the photoelectron spectra and computational evidence of the existence of spin splitting antiferromagnets. In non coplanar antiferromagnetic manganese telluride ($MnTe_2$), we found through spin angle resolved photoelectron spectroscopy that the in-plane component of spin is antisymmetric relative to the high symmetry plane of the Brillouin zone. This leads to a special "lattice like spin texture" in the antiferromagnetic ground state. This unconventional spin polarization signal almost disappears in the high-temperature paramagnetic state, indicating that it originates from the inherent antiferromagnetic sequence. Our research [6] has demonstrated a novel quadratic spin texture induced by time reversal breaking, laying the foundation for spin electronics based on unconventional antiferromagnets.

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