Spin-configuration sensitive magnetic properties of the ferrimagnet semiconductor $Mn_3Si_2Te_6$

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A nodal-line semiconductor is a type of semiconducting material that has a unique electronic band structure. The nodal-line can be formed by simply touching a line of conduction and valence bands, or by degeneracy of each band. This nodal-line is protected by a symmetry that gives rise to non-trivial electronic properties.

Colossal angular magnetoresistance (CAMR) is an electronic phenomenon observed in the presence of nodal-line degeneracy with spin-polarized conduction or valence bands. CAMR results in an extraordinarily high angular magnetoresistance of ~10^9 times difference with rotating magnetization, and has been first reported in $Mn_3Si_2Te_6$ [1]. This finding suggests that spin-orientation can effectively modify electronic properties in similar systems, making magnetic nodal-line semiconductors a promising platform for achieving highly sensitive spin- or orbital-dependent functionalities.

Although the CAMR is considered a common property of magnetic topological semiconductors, its magnetic ground state is still a topic of debate. To enhance of comprehension of the magnetic ground state, we investigate the spin-configuration-dependent magnetic properties using various experimental techniques, such as magnetic susceptibility, electron-spin resonance (ESR), and magnetic torque. Based on the spin-configuration-dependent ESR and torque data, we confirm the noncollinear magnetic structure below T_c, where the spins tilt towards the *c*-axis by ~10 degrees against the basal-plane. We also observe a spin-tilting effect that is dependent on the magnetic fields and temperature, which is in good agreement with the Stoner-Wolfarth model.

[1] Junho Seo, Chandan De, Hyunsoo Ha, Ji Eun Lee, Sungyu Park, Joonbum Park, Yurii Skourski, Eun Sang Choi, Bongjae Kim, Gil Young Cho, Han Woong Yeom, Sang-Wook Cheong, Jae Hoon Kim, Bohm-Jung Yang, Kyoo Kim, Jun Sung Kim, *Nature* **599**, 576-581 (2021).