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Tunable anomalous Hall conductivity through volume-wise magnetic competition in a topological kagome magnet

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Magnetic topological phases of quantum matter are an emerging frontier in physics and material science. Along these lines, several kagome magnets have appeared as the most promising platforms. Recently, we explored magnetic correlations in the kagome magnet $Co_3Sn_2S_2$ [1]. Using muon spin-rotation (μSR) and ARPES, we present evidence for competing magnetic orders in the topological kagome lattice of this compound. Our results show that while the sample exhibits an out-of-plane ferromagnetic ground state, an in-plane antiferromagnetic state appears at temperatures above 90 K, eventually attaining a volume fraction of 80% around 170 K, before reaching a non-magnetic state. Strikingly, the reduction of the anomalous Hall conductivity (AHC) above 90 K linearly follows the disappearance of the volume fraction of the ferromagnetic state. We further show that the competition of these magnetic phases is tunable through applying either an external magnetic field or hydrostatic pressure. Our results taken together suggest the thermal and quantum tuning of Berry curvature induced AHC via external tuning of magnetic order. μSR played a crucial role in this study, since it serves as an extremely sensitive local probe for detecting small moments and ordered magnetic volume fractions in the bulk of magnetic materials.

[1] Z. Guguchia et. al., Nature Communications **11**, 559 (2020).

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