

Investigating the interplay of real space and momentum space Berry curvature on the physical properties of Quantum magnets

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First, we carried out electrical transport studies to uncover the effect of Ba substitution at the Eu site in topological semimetal EuAuBi and, correspondingly, understand how substitution can be an effective means to control the spin textures in this system. Secondly, we performed transport measurements on distorted Kagome material Tb₆Ti₄Al₄₃ to uncover the intrinsic properties of this system.

The real-space magnetic spin textures have been experimentally observed in Dirac semimetal EuAuBi [1]. Prior theoretical studies predict that the partial substitution of Eu with Ba in EuAuBi can modify the long-range magnetic interactions and can drive a transition between Dirac semimetal and Weyl Semimetal. This establishes elemental substitution as an effective tuning parameter for controlling the interplay between magnetism and band topology [2]. Motivated by this, we aimed to understand its effect on the real-space magnetic textures observed in EuAuBi. Since magnetic structure directly governs both real-space and momentum-space Berry curvature, in such systems, tuning magnetic interactions via Ba doping provides a pathway to manipulate emergent spin textures and their associated transport signatures. With increasing Ba concentration, a decrease in the hysteresis feature is observed, consistent with the dilution of magnetic Eu²⁺ interactions by non-magnetic Ba. However, at 15% substitution, hysteresis with magnitude comparable to pristine EuAuBi is observed, which is again suppressed at higher substitution indicating a non-monotonic evolution of magnetic correlations. To further probe the evolution of spin textures, Hall measurements were performed to extract the changes in the topological Hall effect (THE), which can serve as a sensitive tool to probe real-space Berry curvature. For, Eu_{0.95}Ba_{0.05}AuBi and Eu_{0.90}Ba_{0.10}AuBi, a negative THE is observed, which is contrary to positive THE in EuAuBi. Nevertheless, the sign reversal of THE points indicates the presence of spin textures with opposite chirality compared to the parent compound. In conclusion, this study demonstrates that Ba substitution acts as a tuning parameter for controlling real-space spin textures in the system.

Tb₆Ti₄Al₄₃ : The crystal exhibits the antiferromagnetic ground ordering with $T_N \sim 20$ K. For a magnetic field applied along the c-axis ($B \parallel c$), a strong metamagnetic switching is observed, accompanied by clear asymmetric hysteresis at low temperatures, whereas for a field applied along the ab plane, the spin-flop transition is observed. Additionally, the metamagnetic transition is strongly reflected in magneto transport measurements, giving rise to pronounced anomalies in magnetoresistance and an anomalous Hall contribution, despite the ground state of the system being antiferromagnetic. Our results highlight the interplay of geometrical frustration, anisotropic magnetic interactions, and spin-charge coupling in a distorted Kagome antiferromagnet, establishing Tb₆Ti₄Al₄₃ as a promising platform for studying field-induced magnetic phase transitions in frustrated systems.

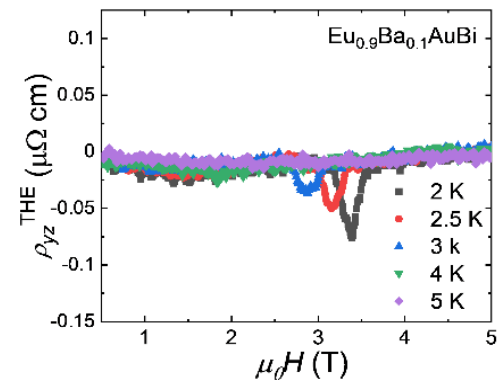


Figure 1: Fig shows the negative topological Hall effect in 10% Ba substituted EuAuBi.

References

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