Anomalous transverse response in topological magnet CeAlSi

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A non-zero Berry curvature, which is a characteristic feature of topological materials, especially in the electronic structure, can be accessed through measurements of the anomalous Hall and Nernst effect [1]. A good candidate for such studies is CeAlSi, a ferromagnetic Weyl semimetal in which Weyl nodes can be tunable in the time reversal breaking regime [2]. We investigated the anomalous Hall conductivity for two different orientations of the magnetic field (B), namely σ_{yz}^{A} for $B \,||\, a$, and σ_{xy}^{A} for $B \,||\, c$ (a and c are crystallographic axes). In the low temperature limit σ_{xy}^{A} and σ_{yz}^{A} turn out to be of opposite sign, which was attributed to shifting of the Weyl point due to reconstruction of the band structure driven by spin reorientation. The anomalous contribution has been also detected in the Nernst conductivity (α_{xy}^{A}/T) measured with B oriented along c - axis. α_{xy}^{A}/T turns out to be large in the low temperature phase and slowly decreases at high temperatures. The ratio of σ_{xy}^{A} and α_{xy}^{A} is a sizable fraction of k_B/e at $\sim 52\,K$ indicating that the anomalous transverse response is fundamentally associated with the nontrivial band structure [3]. Using a single band toy-model assuming a non-zero Berry curvature in the vicinity of the Weyl node, we were able to recreate the temperature dependences of σ_{xy}^{A} and α_{xy}^{A}/T at high temperatures. In this region, large σ_{xy}^{A} and non-vanishing α_{xy}^{A} appear to be consequences of the fact that the Fermi level lies close to the band crossing point.

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