SUPPLEMENTARY INFORMATIONS

Anomalous Nernst effect in the topological and magnetic material $MnBi_4Te_7$

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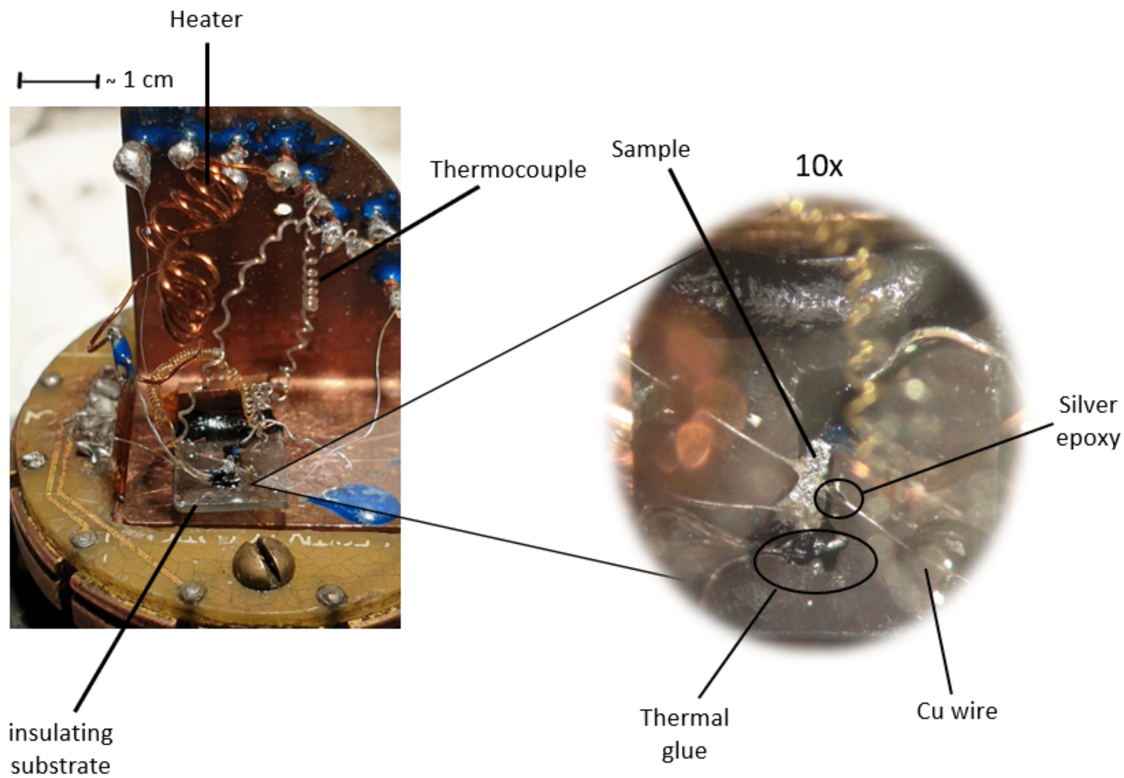
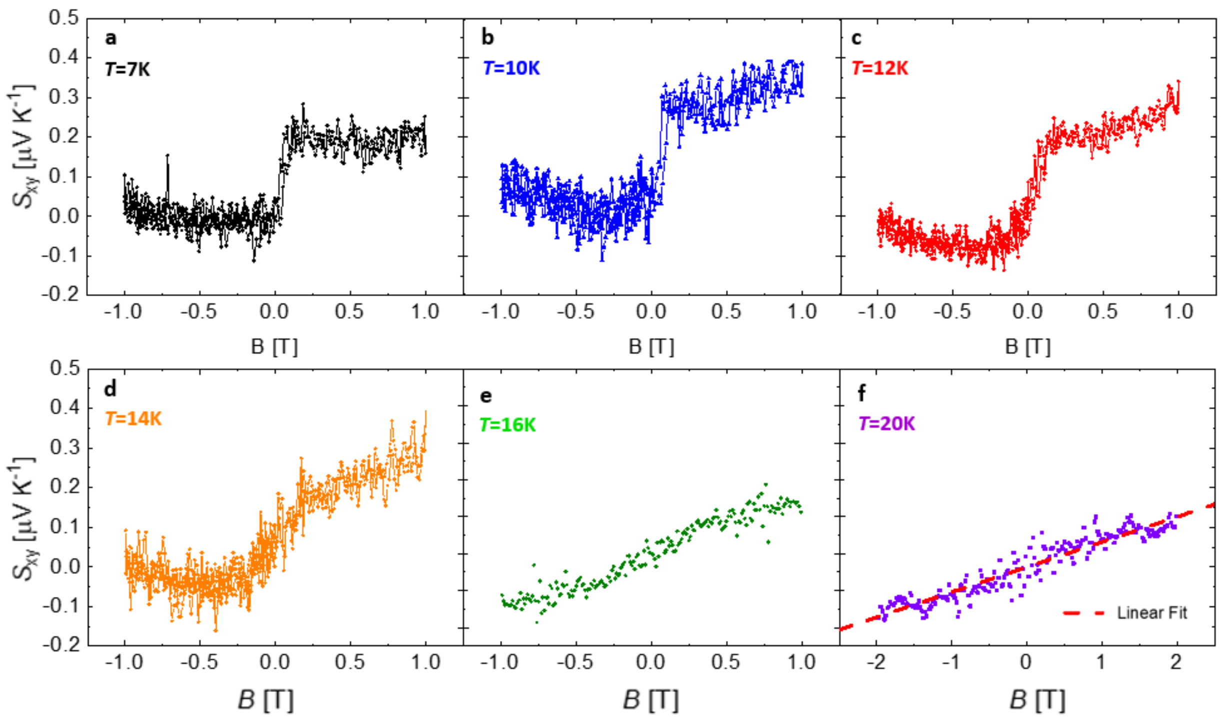
In the Supplementary Figure 1 there is a photo of the $MnBi_4Te_7$ single crystal for the transport measurements.



Supplementary Figure 1. Photo of the thermoelectric measurement assembly. The sample has been glued on a $SrTiO_3$ insulating substrate used as a support due to the limited size of the sample. The heating power has been applied using a resistive heater connected on the one side of the sample with a thermal glue, while a cold finger on the other side of the sample has been linked to the thermal mass in order to complete the thermal circuit. The thermal gradient across the sample has been measured using a thermocouple.

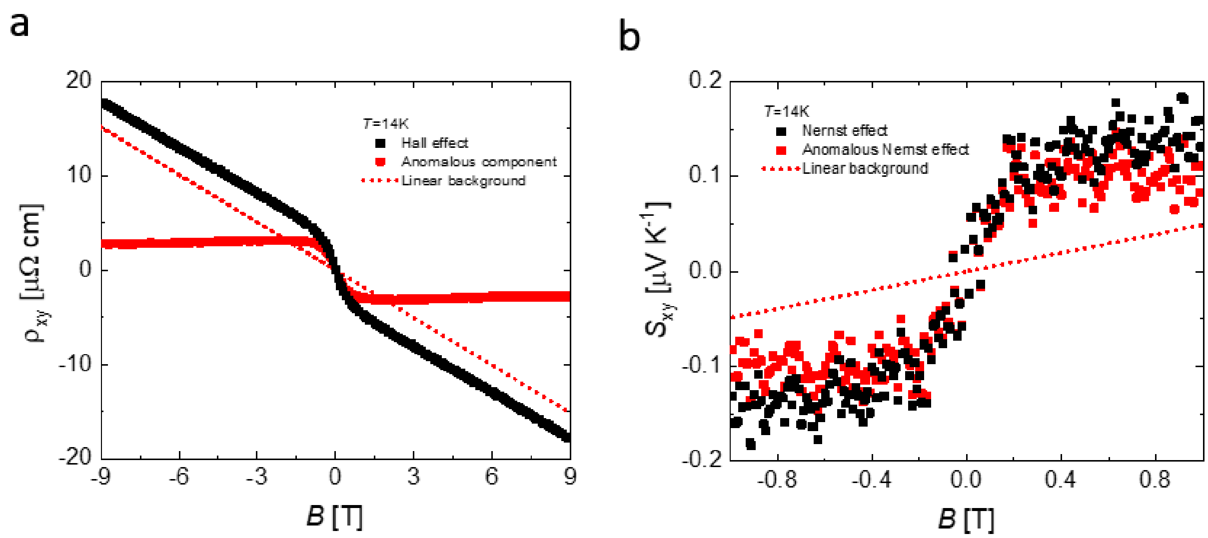
The Supplementary Figure 2 displays the raw data of the transverse thermoelectric signal as a function of th external out-of-plane magnetic field of a $MnBi_4Te_7$ single crystal across the antiferromagnetic transition.



Supplementary Figure 2. Raw data of the Nernst coefficient of a $MnBi_4Te_7$ single crystal a-e) The Nernst transverse thermoelectric signal as a function of temperature and magnetic field for 7 K $< T <$ 16 K and -1 T $< B <$ 1 T. f) The Nernst coefficient at T = 20 K, considering -2 T $< B <$ 2 T and linear fit.

All the curves are characterized by an additional component attributed to the longitudinal Seebeck effect caused by the Nernst contact misalignment and the thermopower of the cabling wires. This spurious term appears as an offset in zero field plus a B-symmetric upturn in the Nernst signals of Figure 2. By changing the magnetic field along a closed cycle, 0 T $\rightarrow$ 1 T $\rightarrow$ -1 T $\rightarrow$ 1T, the data do not reveal reveal any hysteresis within the measurement precision. The absence of any hysteric effect allows the antisymmetrization of S_{xy} vs B in order to extract the pure Nernst coefficient without spurious contributions.

In Supplementary Figure 3 we provide details on how the anomalous contributions can be separated from the total Hall effect ($\rho_{\rm xy}$) or the total Nernst Effect ($S_{\rm xy}$). As an example, we analyze the curves at 14 K. As is discussed in the main text, the temperature is above the antiferromagnetic transition, but the anomalous signal is still present.

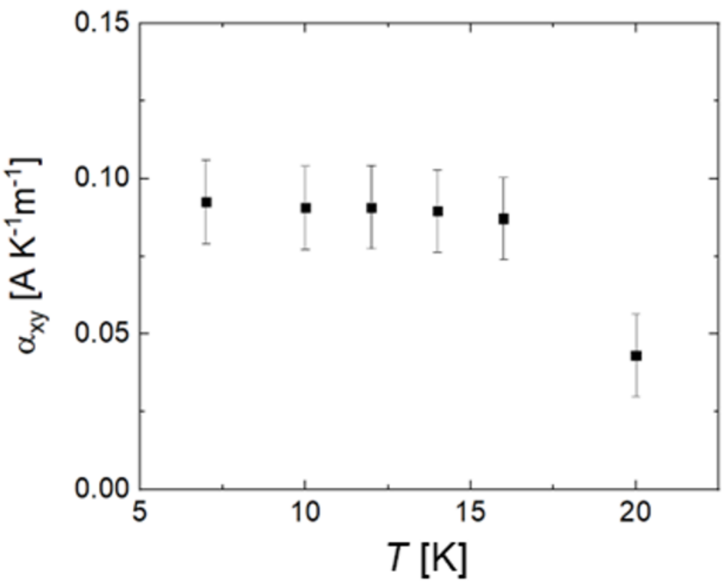


Supplementary Figure 3. Extraction of the anomalous contributions a) Magnetic field dependence of the Hall effect at 14 K of a $MnBi_4Te_7$ single crystal. b) Nernst effect as a function of the external magnetic field at 14 K. In both panels, the anomalous contribution (solid red line) is obtained subtracting the linear background (dashed red line)

$\rho^A_{\rm xy}$ is obtained from $\rho_{\rm xy}$ subtracting the standard linear background, calculated at high fields. Considering a single electron band with carrier concentration n: $\rho^A_{\rm xy} = \rho_{\rm xy} - \frac{1}{ne}$ (Figure 3a).

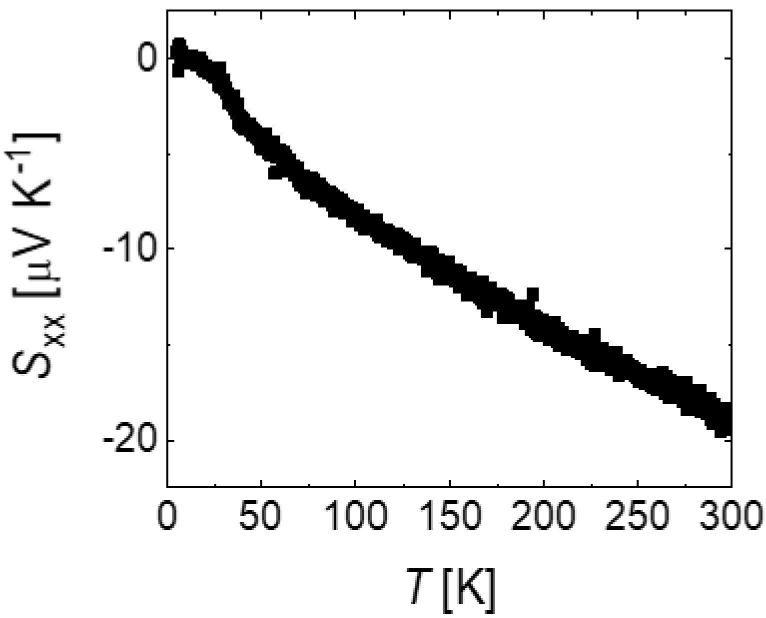
In a similar way, the anomalous Nernst component is obtained from $S_{\rm xy}$ subtracting a linear contribution. In fact, the standard Nernst effect of the conduction band is linear as a function of the external magnetic field (Fig 2f) and it decreases linearly with the temperature [1, 2]. $S^A_{\rm xy}$, at $T = 14$ K, is obtained from the total Nernst effect, subtracting the linear background scaled form the fitted slope at $T = 20$ K (Figure 3b).

In the Supplementary Figure 4 we report the temperature dependence of the transverse thermoelectric conductivity ($\alpha_{\rm xy}$) across the antiferromagnetic transition. The transport coefficient can be evaluated using the formula: $\alpha_{\rm xy} = S_{\rm xy}\sigma_{\rm xx} - S\sigma_{\rm xy}$ [1, 2]. Considering the Mn147 compound at $B = 1\ T$, $\alpha_{\rm xy} \approx S_{\rm xy}\sigma_{\rm xx}$.
$\alpha_{\rm xy}$ shows an enhancement in correspondence of the fully polarized state and it is almost constant for $T < 16\ K$. In the antiferromagnetic state, $\alpha_{\rm xy} = (0.9 \pm 0.1)\ A\ K^{-1}\ m^{-1}$, comparable to other ferromagnetic Weyl semimetals [3, 4].



Supplementary Figure 4. Temperature dependence of the transverse thermoelectric conductivity across the antiferromagnetic transition. The error bars in the Figure are based on the standard deviation. The quantity is calculated at $B = 1$ T.

The Supplementary Figure 5 displays the temperature dependence of the Seebeck coefficient S_{xx} of a $MnBi_4Te_7$ single crystal. A magnitude of 20 $\mu V\ K^{-1}$ at room temperature is compatible to the value reported in literature for Mn124 [5]. Moreover, the absolute value of the Seebeck coefficient decreases monotonically reducing temperature and the negative sign indicates again electron-type bulk charge carriers. For $T < 50$ K, S undergoes an upturn that is related to "drag" mechanisms caused by the bosonic distributions (phonons and/or magnons) in the system, which are also out of equilibrium due to the temperature gradient [1, 2]. Since magnetic phase transitions were not detected, we lean toward a phonon contribution.



Supplementary Figure 5. Temperature dependence of the Seebeck coefficient of a $MnBi_4Te_7$ single crystal.

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