Electronic Supplementary Material (ESI) for Nanoscale.

Supporting Information

Robust Anomalous Hall Effect and Temperature-Driven Lifshitz Transition in Weyl Semimetal Mn_3Ge

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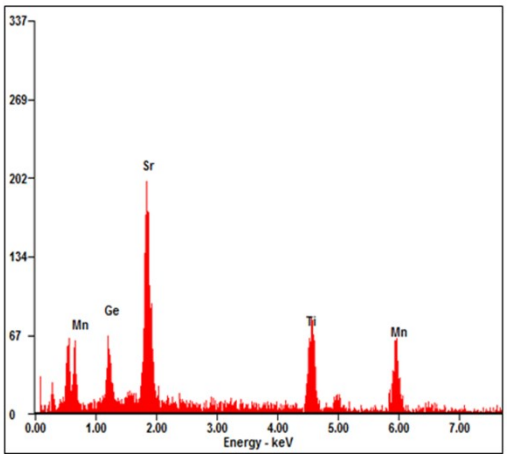
Supplementary Figures & Tables

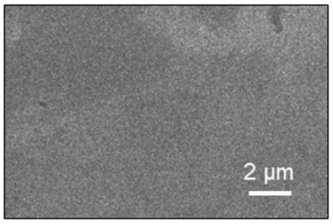
1. Relevant Spectrometer analysis confirming the elementary composition in the Mn_3Ge film

Scanning electron microscopy (SEM) and energy dispersive spectrum (EDS) were used to confirm the chemical constituents of our film. Fig. S1(a) shows the relative energy spectrum intensity for Mn, Ge, Sr and Ti elements in the Mn_3Ge film grown on $SrTiO_3$ substrate. The SEM characterization in Fig. S1(b) reveals that the film is of good crystallinity and free of clusters. The EDS system directly provides the atomic and mass percent profile of main elements, as shown in Fig. S1(c). The atomic ratio of Mn : Ge is about 3 : 1, as expected from the chemical composition.

(a)



(b)



(c)

Element	Wt%	At%
MnK	30.43	35.14
GeL	11.51	10.06
SrL	36.83	26.67
TiK	21.24	28.13

Fig. S1 SEM and EDS scan of Mn_3Ge film grown on $SrTiO_3$ substrate. (a) The energy spectrum of Mn, Ge, Sr and Ti elements, respectively. (b) The detected area of SEM and EDS. (c) Table of the mass and atomic percentage of the related elements.

2. Initial hysteresis loops of antiferromagnetic behavior

Fig. S2 shows two initial hysteresis loops at 300 K and 5 K with diamagnetic background of the substrate, when the magnetic field is applied out of plane. The weak magnetic moments along B || [2 0 $\bar{2}$ 0] indicate non-collinear antiferromagnetic property.

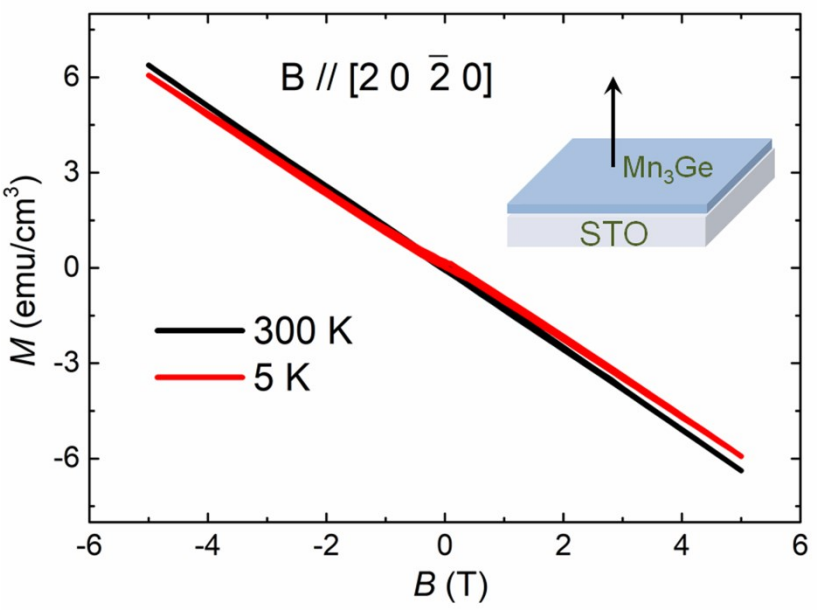


Fig. S2 The initial hysteresis loops of Mn_3Ge film at respectively 300 K and 5 K before subtracting the diamagnetic background of the $SrTiO_3$ substrate.

3. Representative AHE after subtracting OHE

The anomalous Hall effect (AHE) and ordinary Hall effect (OHE) are both included in every Hall measurement in our manuscript. After subtracting OHE, we obtained the AHE behavior of our Mn_3Ge film. Typical AHE and sheet magnetoresistance (MR) at 5 K and 200 K were plotted in Fig. S3. The coercive field H_C of AHE at 5 K reaches an unprecedented value of 5.3 T.

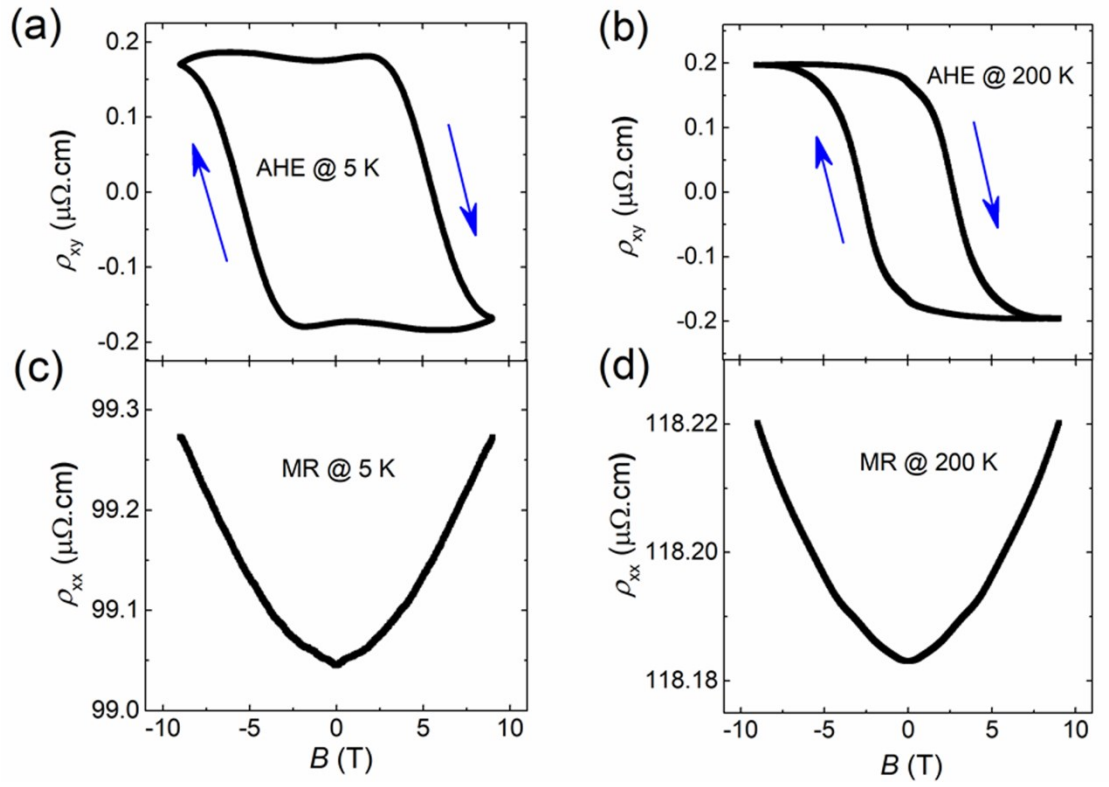


Fig. S3 Typical AHE curves at 5 K (a) and 200 K (b), corresponding with MR results at 5 K (c) and 200 K (d).

4. Magnetoresistance measurements at different temperatures

Fig. S4 provides more MR measurements of our Mn_3Ge film corresponding to the Hall measurements in our manuscript. Similar shapes with various sheet resistivities at different temperatures were obtained. The MR ratio becomes smaller as increasing temperature.

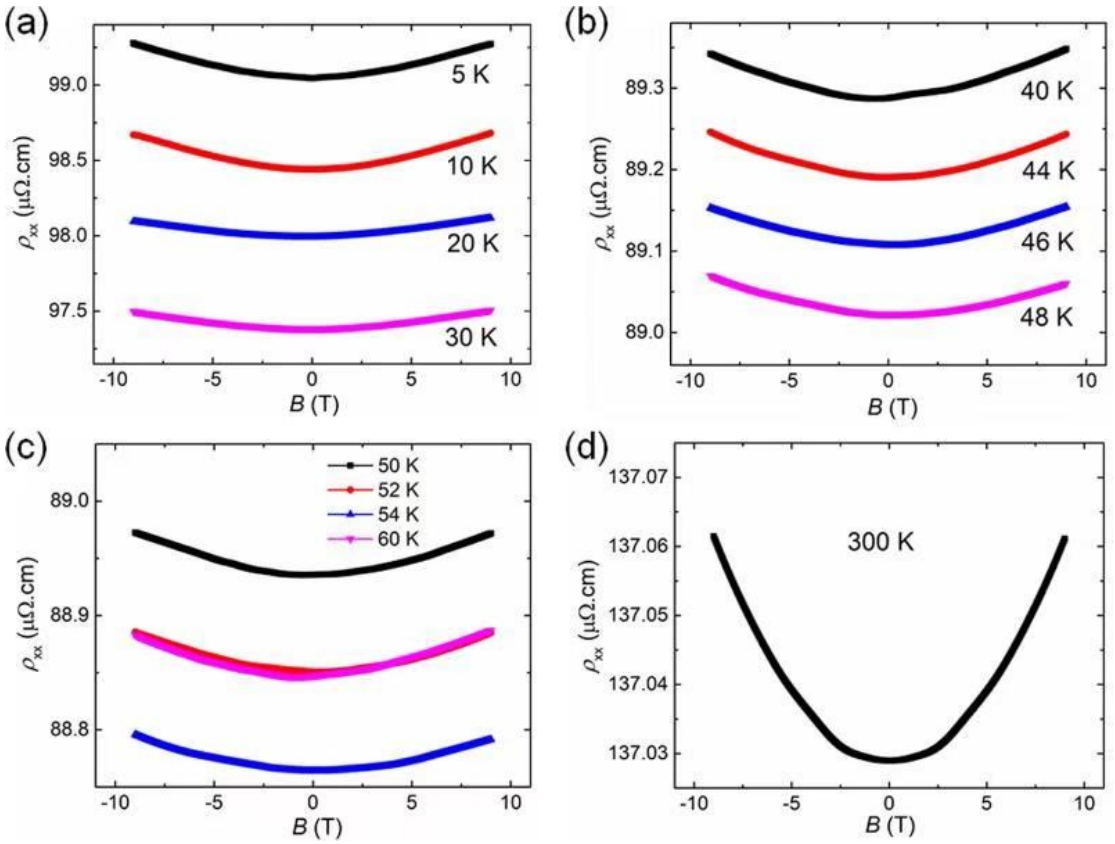


Fig. S4 Magnetic field dependence of sheet resistivity ρ_{xx} measured at different temperatures.