Large Magnetoresistance and Fermi Surface Studies of Sb_2Te_2Se single crystal

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ABSTRACT

We have investigated the magneto-transport properties of topological single crystals, Sb_2Te_2Se. The electrical resistance decreases as temperature decreases, portraying metallic behavior. Under high magnetic fields, magnetoresistance (MR) increases almost linearly with the applied field, and it reaches a value as high as 300 % at 14 T, with no sign of saturation. In addition, the MR shows clear Shubnikov-de Haas (SdH) oscillations with a single frequency. We have studied how the amplitude of the oscillations change with temperature.

WHAT IS A TOPOLOGICAL INSULATOR?

A topological insulator is a material with the interior of an insulator and a highly conducting surface, in which electrons can move along the surface. This material is extremely interesting due to its highly conducting surface states originating from non-trivial bulk states. Due to the unique properties, topological insulators can be used in electronic devices for faster processing as well as quantum computing. There are several topological materials that have been discovered these include Bi_2Se_3, Bi_2Te_3, Bi_2Te_2Se, Sb_2Te_2Se, etc. Topological insulators carry out a unique band structure consists of a valance band and a conducting band with the Fermi level in between the two bands.

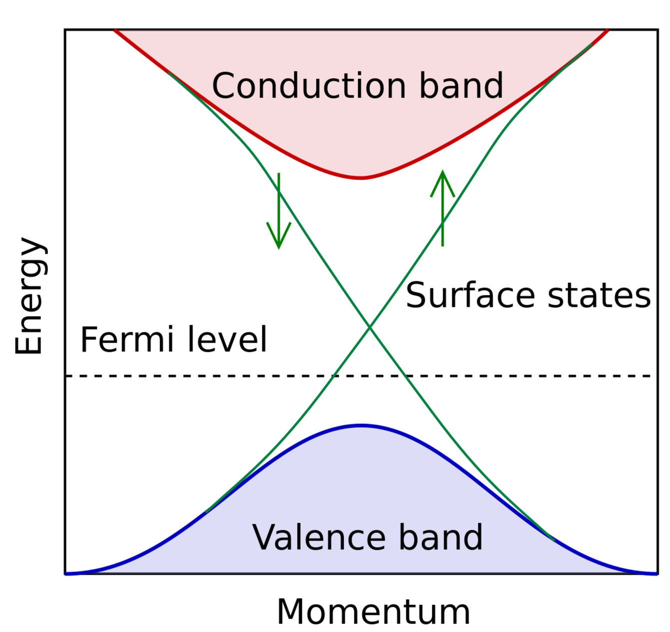

Figure 1: An overview of the band structure of topological insulator.

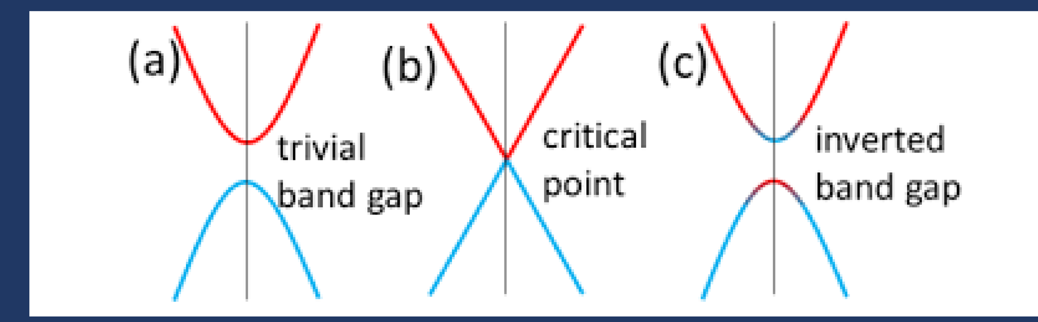

Figure 2: The differences between an insulator (a), a conductor (b), and a topological insulator (c). Trivial insulator has a well-separated valence and conductor bands, they are touching each other in a conductor, and inverted in an topological insulator.

METHODOLOGY

- Magnetoresistance (MR) measurements under the fields up to 14 T and temperature down to 2 K were carried out in PPMS (Dynacool).
- Third order polynomial background was subtracted in MR data for determining the frequency.

RESULTS

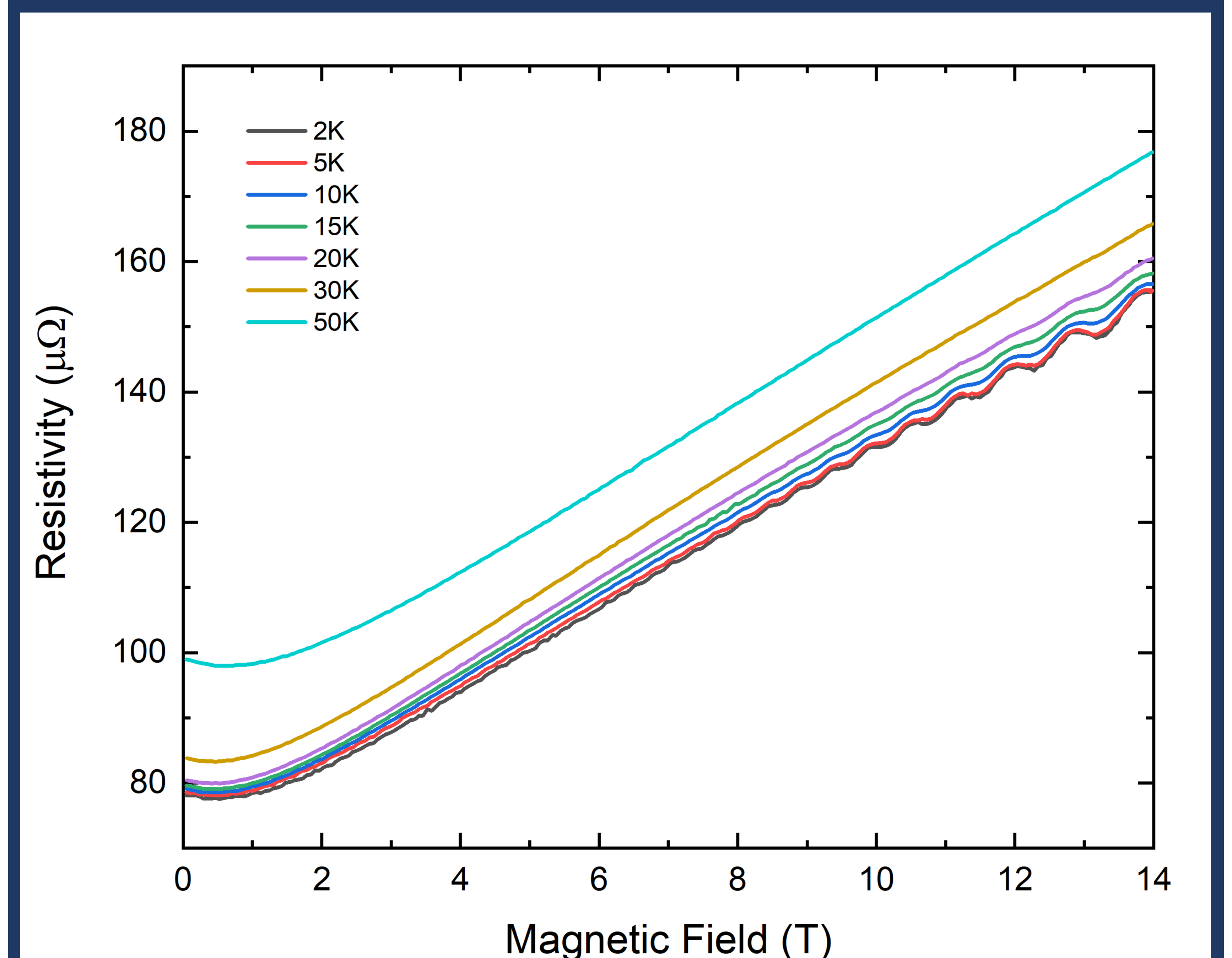

Figure 3: Magnetoresistance (MR) of Sb_2Te_2Se sample at different temperatures. MR increases with magnetic fields showing positive MR. At higher fields, they show clear Shubnikov de-Haas oscillations. At higher temperatures (above 30 K), the oscillations disappear.

REFERENCES

1. Shrestha, K., Marinova, V., Graf, D., Lorenz, B., & Chu, W. (2017). Large magnetoresistance and Fermi surface study of Sb_2Se_2Te single crystal. Journal of Applied Physics 122.
2. Hasan, M.Z., & Kane C.L. (2010). Colloquium: Topological insulators. Reviews of Modern Physics 82.

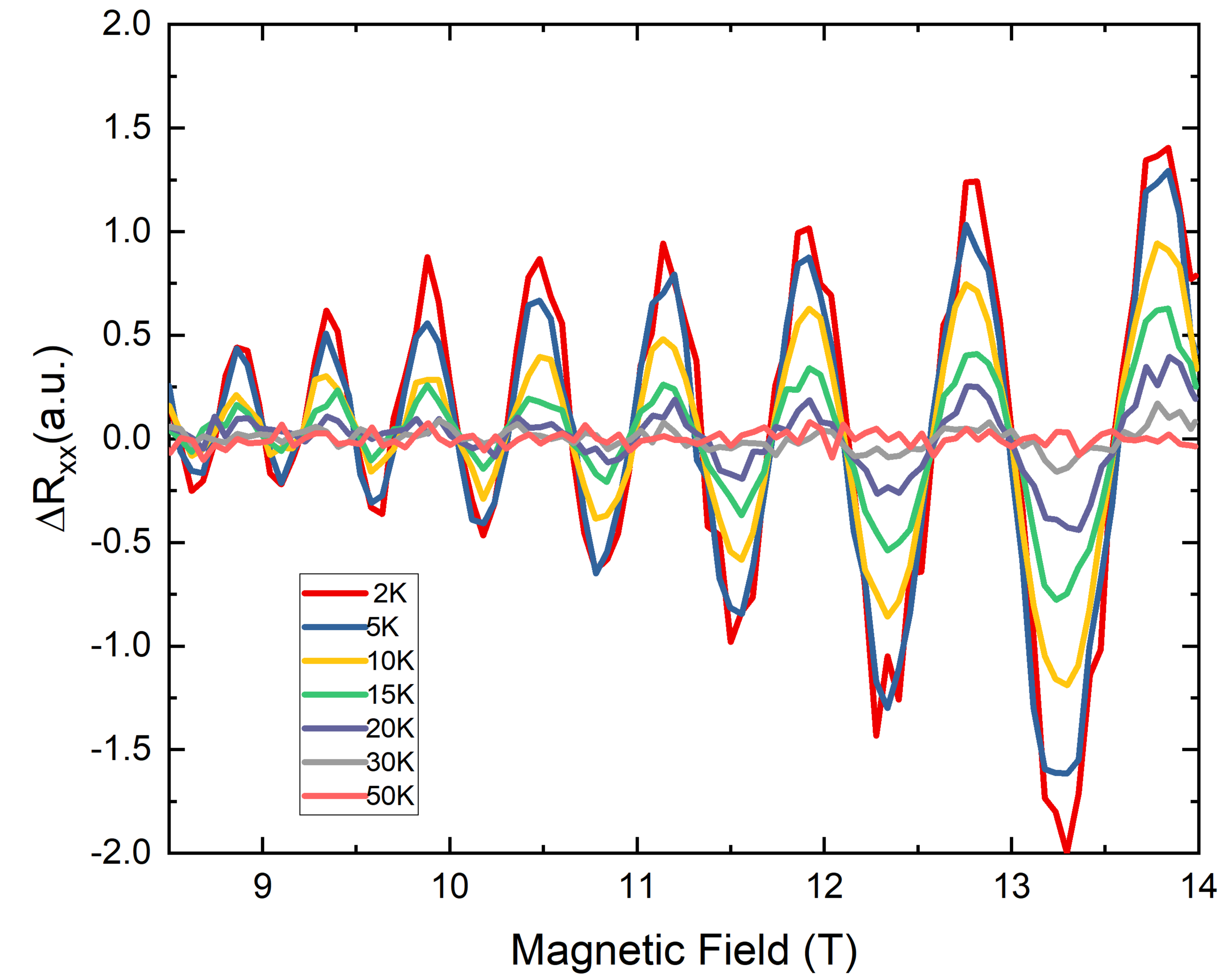

Figure 4: Quantum oscillations after subtracting the third order polynomial background at different temperatures. The oscillations are smooth and periodic. The frequency of the oscillations can be determined using the Fourier transform.

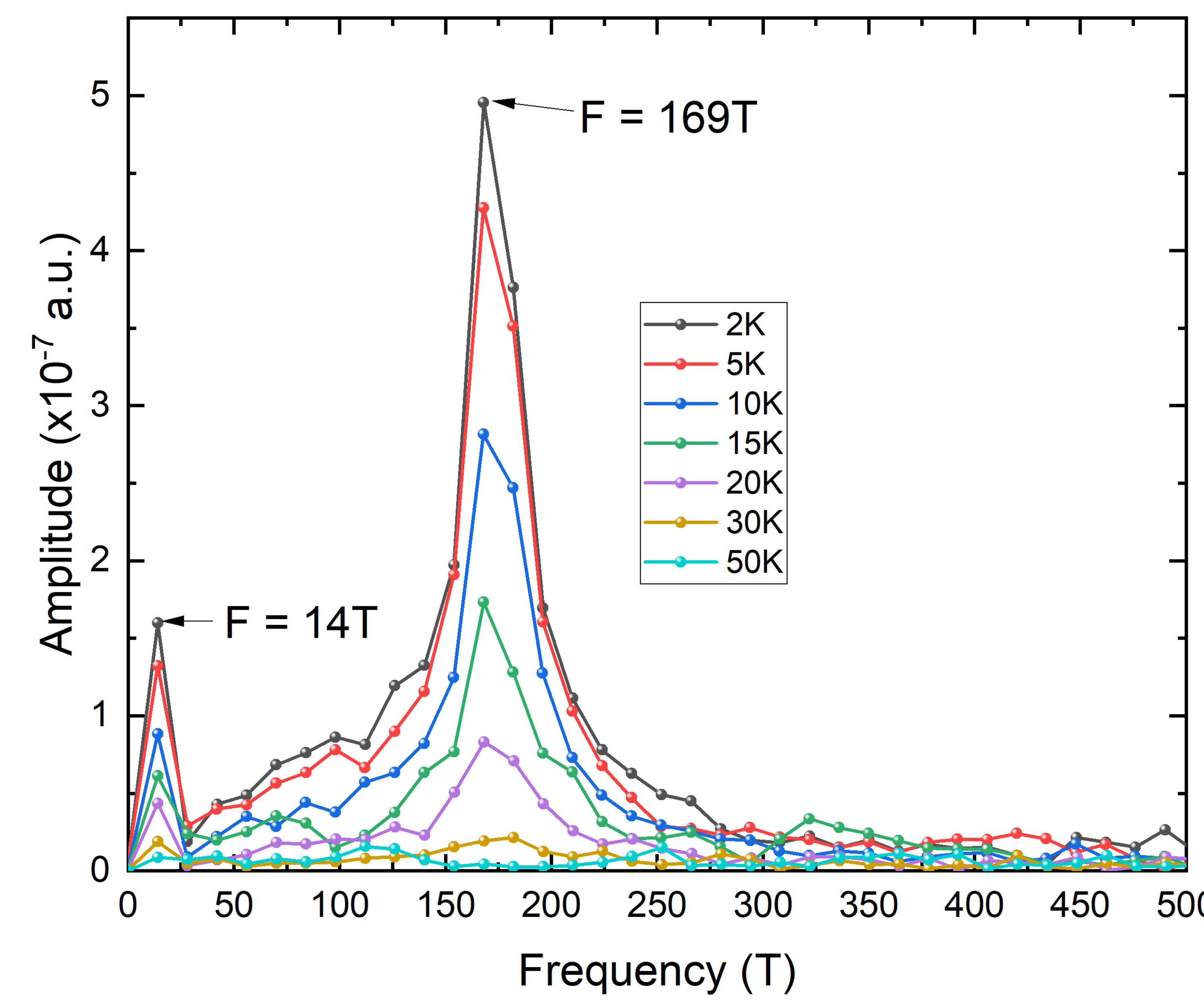

Figure 5: The figure shows two peak frequencies at 14 T and 169 T, suggesting that there could be two Fermi surface sections. More experimental data such as SdH oscillations at different angles and Berry phase analysis are needed for a decisive conclusion.

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