The Aharonov-Bohm oscillation in the $BiSbTe_3$ topological insulator macroflake

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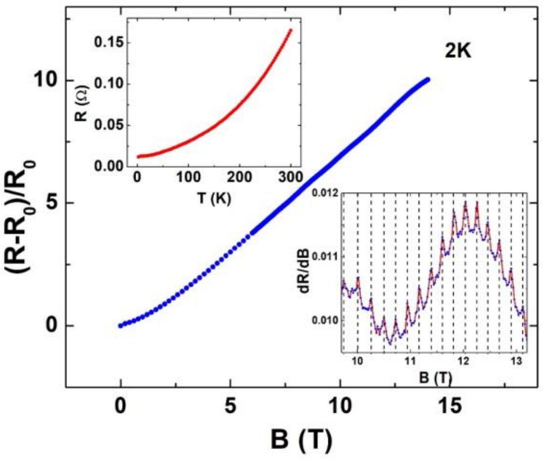
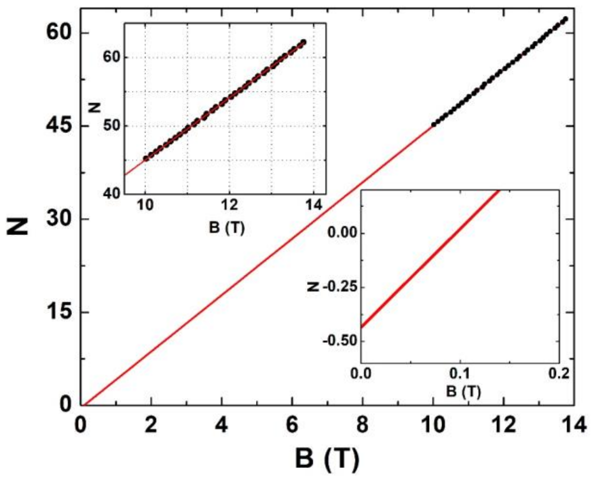
Background

- Wavefunction interference leads to many interesting transport characteristics, such as weak localization, universal conductance fluctuations, Aharonov-Bohm (AB) oscillation, and persistent current. These quantum interference effects strongly depend on system geometries and carrier phase coherence lengths.
- The phase coherence length is sensitive to various kinds of scatterings such as electron-phonon and electron-electron interactions. Due to the short coherence length, these quantum interference effects are mainly reported in geometry-confined nanosystems.
- The linear dispersion of surface state leads to high carrier mobilities, and experimental works reveal that the coherence length could reach sub μm. This is a proper material to realize the quantum interference effect in a macroscopic system without artificial treatments.
- In this work, we first reported the Aharonov-Bohm effect in a mm-scale macroflake in BiSbTe3 topological insulator, and the related transport characteristics were further identified.

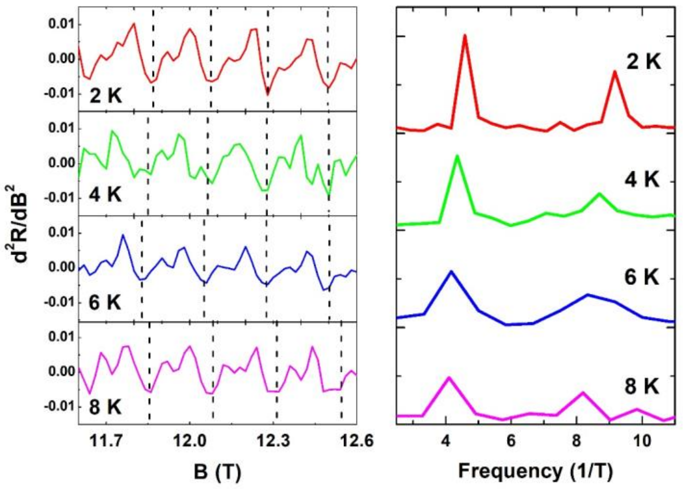
Results and Discussions



- The magnetoresistance as a function of magnetic fields at 2 K. The magnetoresistance ratio reaches 1000 % at 14 T.
- The left-top inset shows the temperature dependence resistance, and the residual resistance ratio is 14.
- The right-bottom inset shows the first derivation of the measured magnetoresistance. It shows periodic AB oscillations. The long-range oscillation originates from the Shubnikov-de Hass oscillation at high magnetic fields.

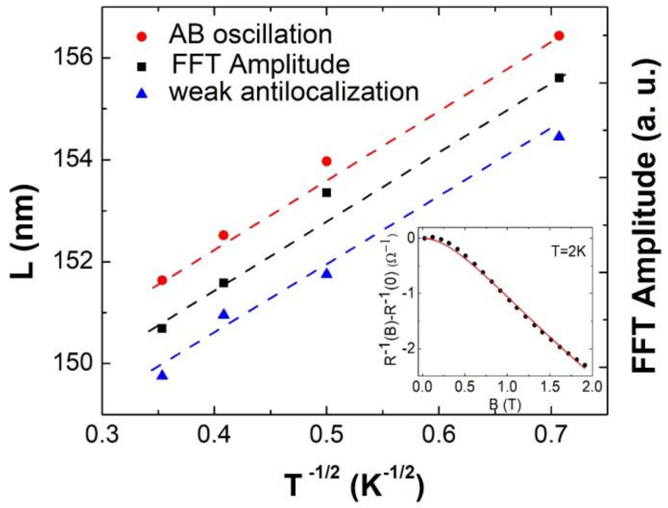


- The index numbers of oscillation peaks and dips in the first derivation as a function of corresponding magnetic fields. As shown in the inset, the intercept is -0.45 that indicates the Berry phase is π.

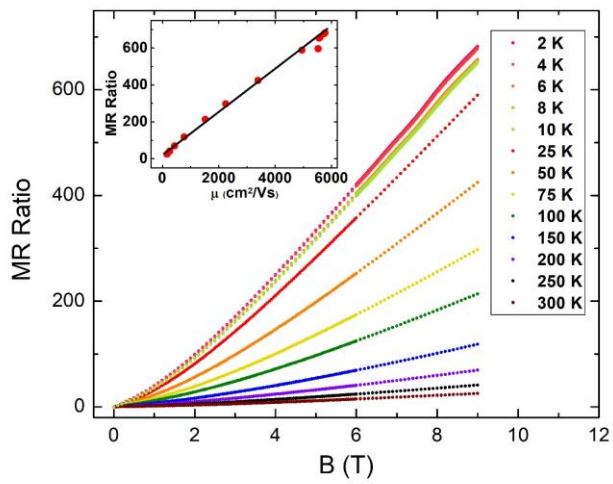


- The second derivation of the measured magnetoresistance at several temperatures.
- The fast Fourier transformation shows two prominent peaks. The first prominent oscillation peak is from the AB oscillation and the second prominent oscillation peak is from the Altshuler-Aronov-Spivak effect.

Results and Discussions



- The inset shows the measured magnetoresistance goes well with the theoretical curve. The extracted carrier elastic scattering length from the weak antilocalization is consistent with that extracted values from AB oscillations.
- The elastic scattering length is proportional to the $T^{-1/2}$. The FFT amplitude follows the $T^{-1/2}$.



- The magnetoresistance ratio as a function of magnetic fields at several temperatures. It reveals that the magnetoresistance ratio increases as temperature decreases, and it reaches 700% at 9 T and 2 K. The inset reveals that the magnetoresistance ratio is proportional to the effective carrier mobility.

Conclusions

- We report the AB oscillation in the BiSbTe3 topological insulator macroflake. The magnetoresistance reveals periodic oscillations. The oscillation index number reveals the Berry phase is π that supports the oscillation originates from the surface state.
- The AB oscillation frequency increases as temperature decreases, and the corresponding phase coherence length is consistent with that extracted from the weak antilocalization. The phase coherence length is proportional to the T $T^{-1/2}$.
- The magnetoresistance ratio reaches 700% (1000%) at 9 T (14 T) and 2 K, and it is proportional to the carrier mobility. The MR ratio is larger than all reported values in (Bi, Sb)2(Te, Se)3 topological insulators.