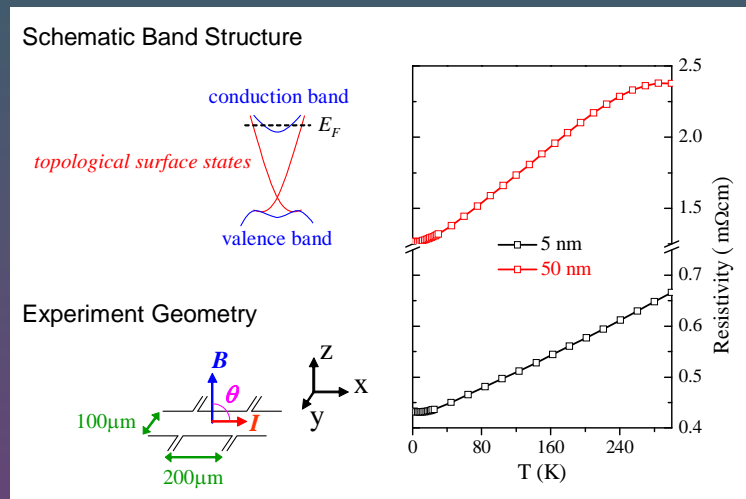


# Impurity Effect on Weak Antilocalization in the Topological Insulator $\text{Bi}_2\text{Te}_3$

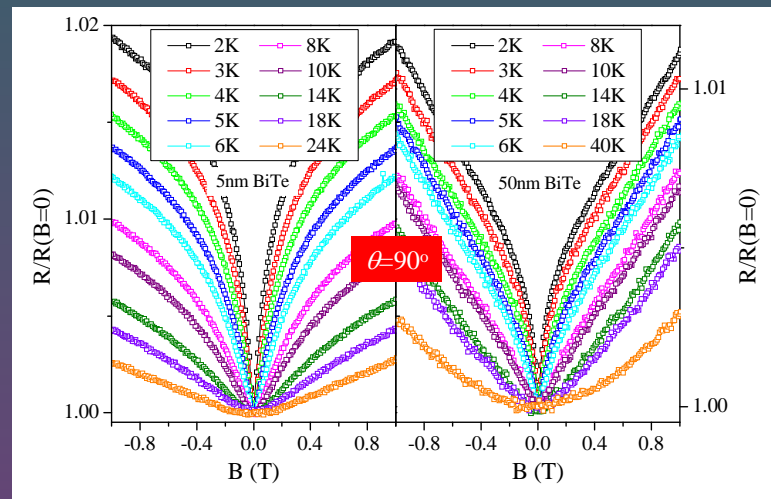
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Physical Review Letters 106, 166805 (2011)

We study the weak antilocalization (WAL) effect in topological insulator  $\text{Bi}_2\text{Te}_3$  thin films at low temperatures. The two-dimensional WAL effect associated with surface carriers is revealed in the tilted magnetic field dependence of magnetoconductance. Our data demonstrate that the observed WAL is robust against deposition of nonmagnetic Au impurities on the surface of the thin films, but it is quenched by the deposition of magnetic Fe impurities which destroy the Berry phase of the topological surface states. The magnetoconductance data of a 5 nm  $\text{Bi}_2\text{Te}_3$  film suggests that a crossover from symplectic to unitary classes is observed with the deposition of Fe impurities.

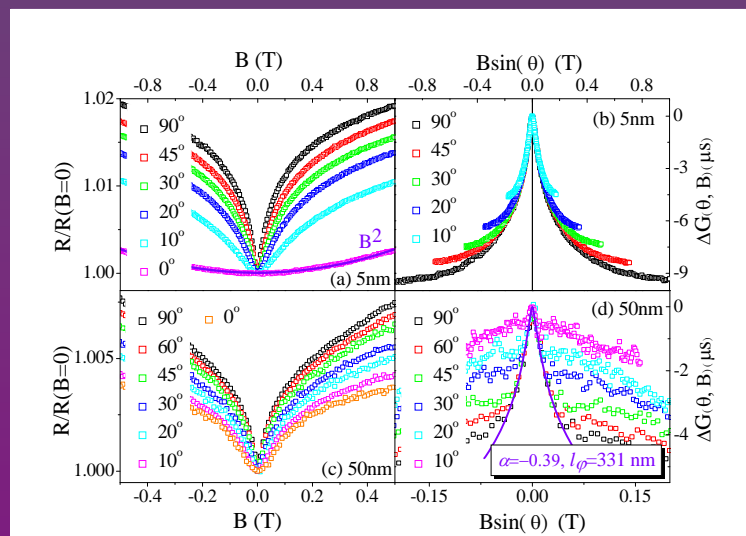
## I. Temperature Dependent Resistivity



## II. Temperature Dependent Weak Antilocalization

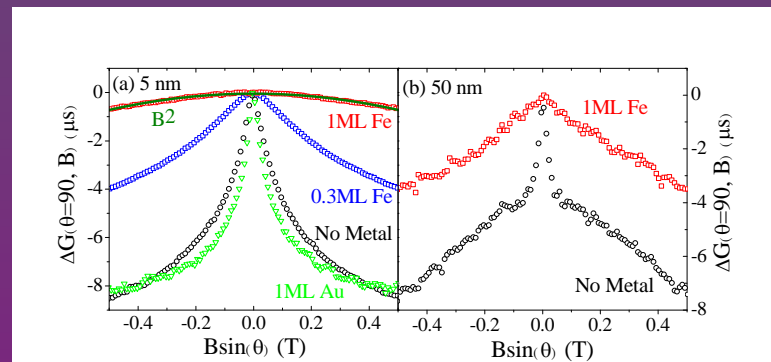


## III. 2D Weak Antilocalization Revealed in Tilted B Field Measurement



- ◆ With the bulk contribution subtracted, the obtained  $\Delta G$  curves as a function of normal  $B$  component ( $B_{\perp} = B\sin(\theta)$ ) coincide at low  $B$  fields, indicating the presence of 2D weak antilocalization in 5 nm (b) and 50 nm (d) films. ( $\Delta G(\theta, B) = 1/R(\theta, B) - 1/R(\theta=90^\circ, B)$ )
- ◆ The 2D nature of weak antilocalization points to the existence of topological surface states in  $\text{Bi}_2\text{Te}_3$  films. This 2D WAL could be well fitted by the HLN model<sup>1</sup>, as shown in (d).

## IV. Impurity Effect on 2D Weak Antilocalization



- ◆ The 2D weak antilocalization is robust against the deposition of 1 monolayer non-magnetic Au impurities on the film surface, but quenched by the magnetic Fe deposition.
- ◆ Time reversal breaking Fe impurities destroy the  $\pi$  Berry phase of the topological surface states, giving rise to the quenching of the 2D weak antilocalization.
- ◆ The parabolic  $B$  dependent magneto-conductance obtained with 1 monolayer Fe deposition shown in (a) is a clear signature of the crossover from the symplectic to unitary class.

<sup>1</sup>: S. Hikami *et al.*, Prog. Theor. Phys. **63**, 707 (1980)