# Exploration of Novel Magnetism in Interfacial Strongly Correlated Materials

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## Introduction

The discovery of topological insulators and possible topological superconductors opens a new area of study and brings hope to more exciting applications such as topological quantum computation [1]. In Cu doped $Bi_2Se_3$ single crystals, a superconducting ground state was observed at T < 3.8 K. However, the magnetic and electronic structure is not well understood in the normal state of Cu doped $Bi_2Se_3$. The material is diamagnetic even in the normal state. The estimate of effective mass in the ARPES results well above $T_c$ is very different from that of the heat capacity [2, 3]. More importantly, the exact Fermi surface topology was not clearly determined in the ground state since the quantum oscillation of the bulk state has not been observed. Our solution is to study the magnetic and electronic structure using high-resolution torque magnetometry [4, 5, 6]. Recently, we were able to resolve the quantum oscillations [7] of Cu doped $Bi_2Se_3$, providing a sensitive probe to the Fermi surface of the topological superconductor candidate Cu doped $Bi_2Se_3$.

## Experimental

High-resolution torque magnetometry was used to measure the magnetic moment of the samples. Torque is measured as the change of the capacitance between the metal cantilever and a nearby metal plate.

## Results and Discussion

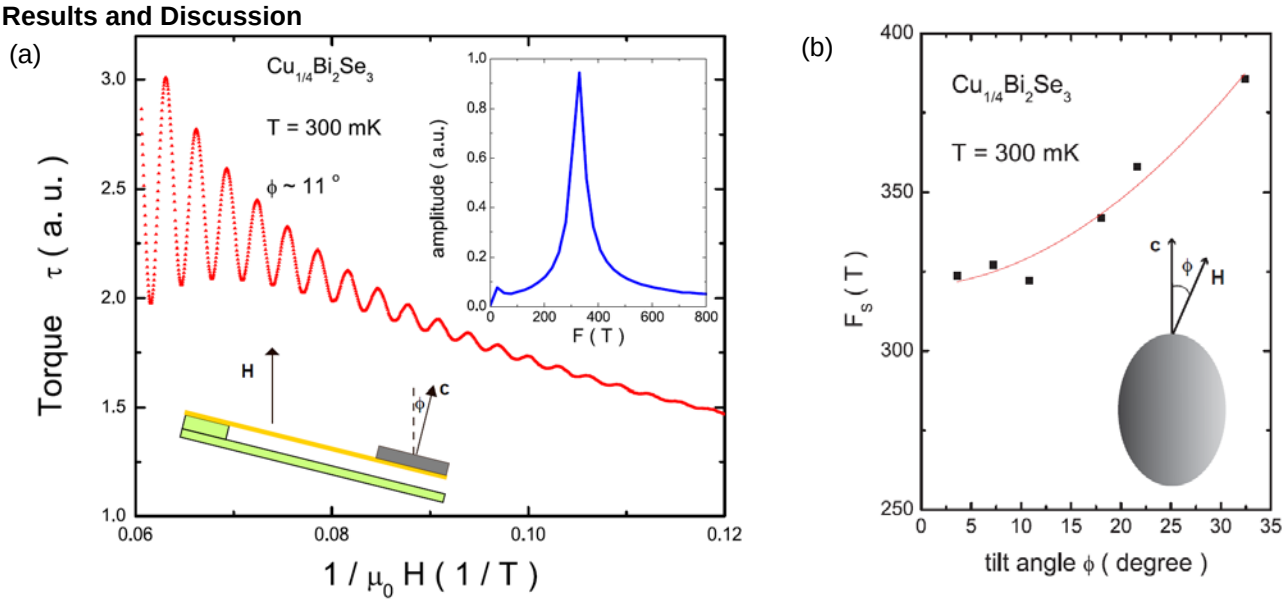


**Figure 1**. de Haas-van Alphen effect of topological superconductor Cu doped $Bi_2Se_3$. (a) Quantum oscillation pattern observed in the torque magnetometry. The lower left panel shows the sketch of the measurement setup. (b) Angular dependence of the oscillating frequency. The lower insert shows a sketch of the estimated Fermi surface.

## Conclusions

Our quantum oscillations results confirm the 3D Fermi surface in Cu-doped $Bi_2Se_3$. The doping of Cu changes the carrier density, but the Fermi velocity stays the same. Our result suggests the conduction electrons are in the Dirac-like band in Cu-doped $Bi_2Se_3$.

## Acknowledgements

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## References

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