Electrically Detected Magnetic Resonance Study of Transition Metal Penta-Telluride

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Introduction

A quantum spin Hall (QSH) insulator has topologically protected states that enable dissipation-less transport. Unfortunately, all the QSH insulators discovered to date possess a small band gap that is not useful for room temperature applications. Recently, transition-metal penta-tellurides ($ZrTe_5$ and $HfTe_5$) have been predicted as possible candidates for hosting a large-gap QSH insulator phase in their monolayer form and three-dimensional topological insulators in the bulk [1]. Follow-up experimental investigations have also revealed an exceptionally low magnetic field for reaching the quantum limit and a large *g* factor as large as 24 [2]. The latter makes electron spin resonance a suitable technique for a detailed study of their electronic structures.

Experimental

Single crystal of HfTe5 is grown using chemical vapor transport technique. Here, we used electrically detected magnetic resonance (EDMR) technique since the sample has very small cross section area. Specifically, the sample was illuminated with microwave modulated with an optical chopper at frequency f, and the longitudinal resistance is monitored under constant current bias as a function of magnetic fields using locking technique.

Results and Discussion

Fig.1 compares the resistance measured by the standard electrical measurement and the EDMR techniques.
Both techniques detected the resistance oscillating with magnetic fields. Due to the modulation technique, the non-oscillatory background in the EDMR resistance is largely suppressed, leading to a much prominent oscillation amplitude. However, we notice that the EDMR oscillation may have a different origin than the quantum oscillation since they do not follow the same frequency. More interestingly, we noticed a sharp resonance-like signal around 2.3 T labeled out by the arrow. We attributed this to an electron-spin signal since this kink quickly disappeared as the microwave frequency changed. Further experiment is needed to thoroughly explore this resonance phenomena with a broadly tuned microwave frequency.

Conclusions

We have performed EDMR measurements on an emerging topological material $HfTe_5$, which may allow us to observe a different oscillation mechanism other than quantum oscillations. In addition, we observe a possible spin-resonance like signal. However, its origin still under exploration.

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References

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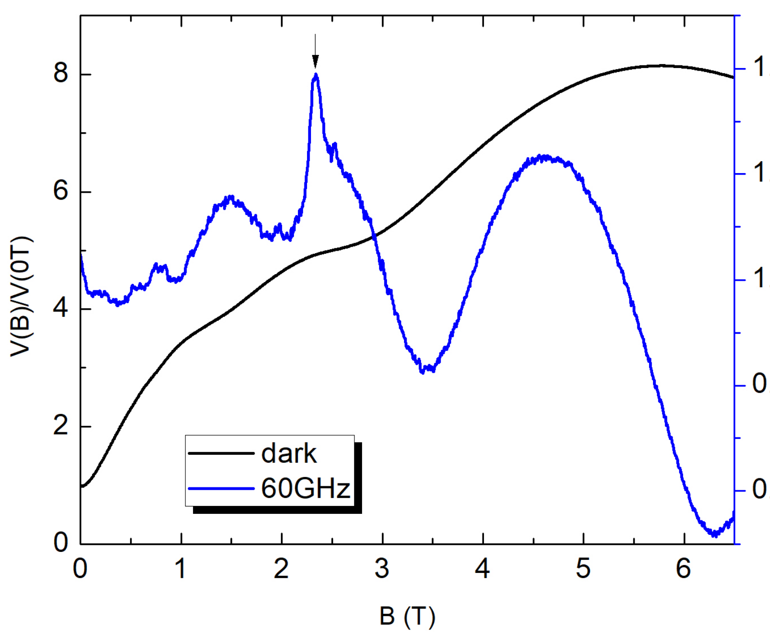

Fig.1 Resistance of $HfTe_5$ as a function of magnetic field measured by standard resistance measurement technique (black lines) without any microwave radiation and EDMR at 60GHz (blue line).