The Search for the Fractional Quantum Hall State in the 3D Topological Insulator HgTe

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Introduction

Topological insulators are a new class of materials, which feature gapless surface states and bulk insulator behavior due to an inverted bulk band structure [1]. The first topologically non-trivial state, the quantum spin Hall state, was predicted [2] and experimentally verified [3] in a quantum well structure based on CdTe/HgTe. Shortly after, 2D surface states in a strained bulk sample of HgTe were discovered through quantum Hall measurements that featured a specific sequence of quantized conductance plateaus as a function of magnetic field [4]. Due to limited magnetic field range, the regime of fractionalized filling factors have been elusive to experiments in this material system so far.

Experimental

Magneto-transport experiments were conducted in 4 probe geometry on thin layers of 70nm HgTe on CdTe substrates. NHMFL SC-II (18T) and cell 7 (30T) magnet systems were utilized.

Results and Discussion

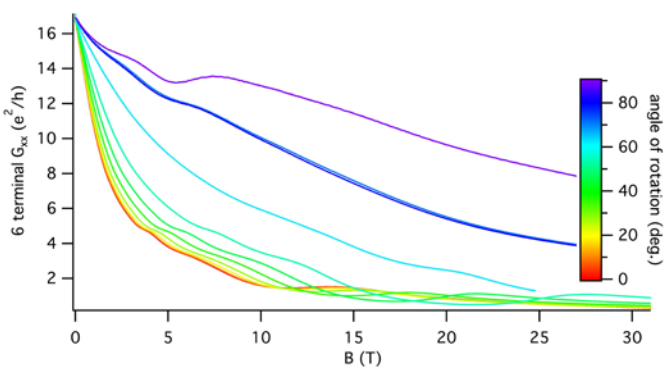

Figure 1 Angle dependent longitudinal conductance

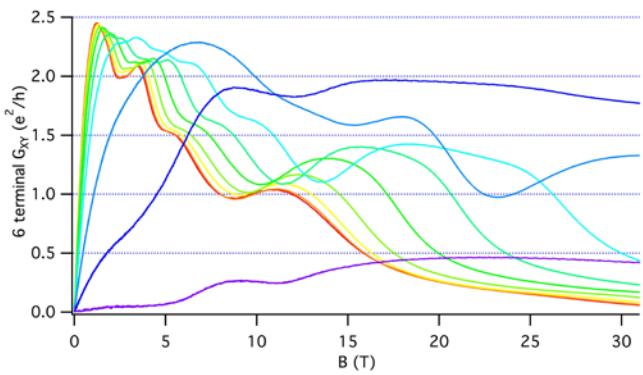

Figure 2 Angle dependent Hall conductance

Figure 1 shows angle dependent longitudinal conductance of a sample grown on a (211) CdTe substrate at T=300mK. **Figure 2** shows the Hall conductance accordingly. Clear and robust plateau like features at integer filling fractions are observed. The angle dependence of the plateaus proves the 2D nature of the observed features. In the regime of expected fractional filling, no definitive plateau like feature is observed but a transition to an insulating state. The background conductance hints towards significant contribution of the omnipresent non-chiral edge states ("facet states"); signatures of quantized transport in those conductance channels are found for in-plane magnetic field.

Conclusions

Clear and robust quantized 2D transport features in a bulk strained film of the topological insulator HgTe have been observed. Despite the high quality of the samples, no clear indication for fractionalized quantum Hall features is observed. The role of the non-chiral side states in Tis is demonstrated.

Acknowledgements

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References

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