Ultra-quantum Limit Magnetotransport in the Topological Pentatellurides

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With low carrier concentrations and high mobilities, the pentatelluride material family ($HfTe_5$ and $ZrTe_5$) typically have a quantum limit of a few Tesla, making them an ideal platform to study ultra-quantum limit phenomena and magnetic field-induced effects in a three dimensional (3D) Dirac fermion system. In the quantum limit, the magnetic field is strong enough to confine all the electrons to their lowest Landau levels, resulting in a quantized in-plane dispersion, lower effective dimensionality, and a system that is more unstable to electronic correlations. Previous experiments in the pentatellurides have revealed many exotic high-field phenomena including an interaction driven instability [1] and a field induced Lifshitz transition [2]. These materials sit right at the cusp of a strong-to-weak 3D topological phase transition, resulting in a band structure and electronic properties that are extremely sensitive to external tuning parameters such as magnetic field and strain [3]. Consequently, while these systems are promising for the extrinsic control of topological properties, there are many controversies surrounding their intrinsic behavior as the electronic properties depend on the sample growth and preparation conditions [4].

In this work we report on the ultra-quantum limit electronic properties and magnetic field-temperature phase diagram of flux grown, bulk $HfTe_5$ as revealed by magnetotransport measurements in pulsed magnetic fields up to 65 T (Fig. 1). These samples show a purely insulating resistance vs temperature behavior in zero field. We find a strong and non-monotonic angle dependence of the magnetoresistance and several high field features in the ultra-quantum limit. The interpretation of these features will be discussed during the presentation.

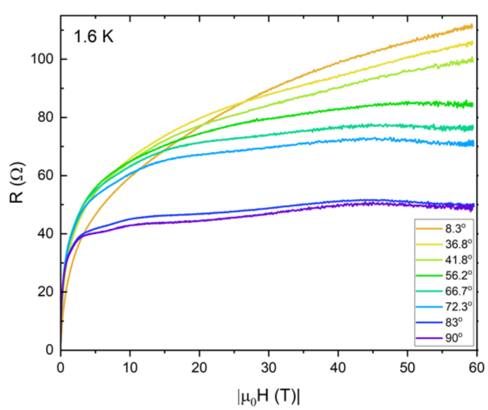

Figure 1: Pulsed field magnetotransport of $HfTe_5$ as a function of in-plane magnetic field angle. H⊥a, I//a.

[1] L. Yanwen et al. Nat. Commun. **7**, 12516 (2016)
[2] S. Galeski et al. Nat. Commun. **13**, 7418 (2022)
[3] J. Mutch et al. Sci. Adv. **5**, eaav9771 (2019)
[4] J. Liu et al. arXiv:2304.09072 (2023)

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