# Quantum Oscillations in BiTeX (X=Cl, Br)

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## Introduction

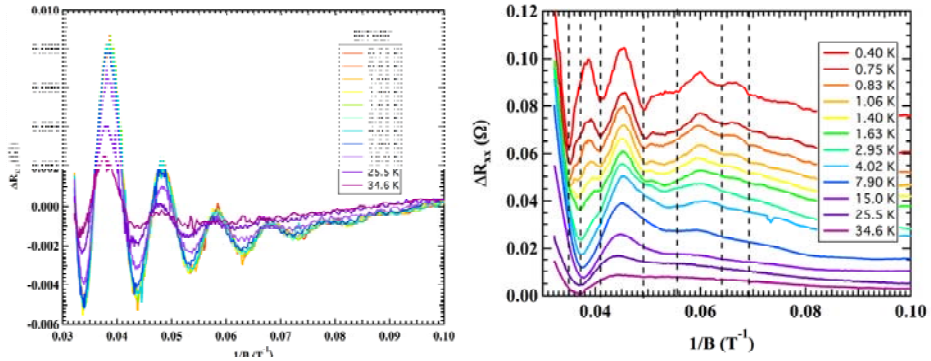
Bismuth-telluride compounds have attracted considerable attention over the past years due the observation of a large Rashba spin splitting of the bulk electronic bands [1]. While there are still outstanding questions concerning the possible charge accumulation at the surface, it has just been reported, from photoemission data, the observation of topological insulating state in BiTeCl [2]. To gain insight into the structure of the Fermi surface and electronic properties, we performed high magnetic field transport measurements on BiTeCl and BiTeBr.

## Experimental

Single crystals of BiTeX (X=Cl, Br) were grown by chemical vapor transport and Bridgman methods. Optical reflectance and Hall effect measurements were initially performed on samples in order to determine their bulk properties. Then we attached gold wires and measured high magnetic field resistivity, up to 32 Tesla, using the Cell 9 facility at the National High Magnetic Field Laboratory in Tallahassee.

## Results and Discussion

We successfully detected quantum oscillations in both compounds at fields above 18-20 T, as it can be observed in the figure below. For a Rashba-split conduction band, two oscillation frequencies are expected, corresponding to the inner (IFS) and outer Fermi surface (OFS), respectively. We observed unambiguously only one frequency, most likely from the OFS, but there is also hint of a low frequency oscillation in both samples.




We notice that for the BiTeBr compound (left Fig.), carrier concentration obtained from the plasma frequency in optical data, SdH effect and Hall effect agrees well with each other, consistent with the bulk electronic properties. In BiTeCl however (right Fig.), while the optical data and Hall effect do result in the same carrier concentration, SdH oscillations indicate a much larger Fermi surface, indicative of a different origin, most likely from surface, of the quantum oscillations. We plan further experiments, possibly at higher magnetic field in order to better understand the origin of the SdH effect in BiTeCl.

## Conclusions

We measured SdH effect in the Rashba spin-splitting compounds BiTeBr and BiTeCl. In BiTeBr the oscillations are in good agreement with the bulk carriers, as characterized by optical spectroscopy and Hall effect. Large discrepancy between the sizes of the Fermi surface (carrier concentration) determined from optics or Hall data and that from the SdH effect was observed. This suggests that the oscillations in BiTeCl do not originate from bulk.

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## References

[1] Ishizaka, K. et al., Nature Materials, 10, 521 (2011).
[2] Chen, Y. L. et al., Nature Phy. 9, 704-708 (2013)