Signature of Chiral Anomaly and Magnetotransport in (001) Strained Grey Tin

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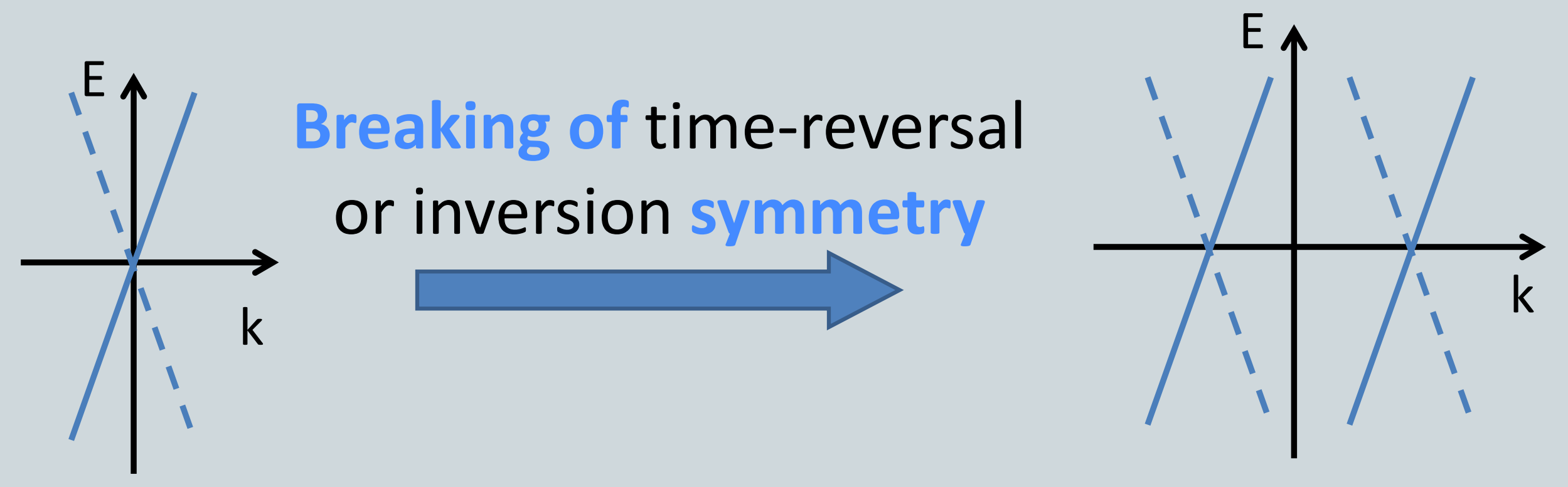
MOTIVATION

BACKGROUND

Topological Dirac and Weyl semimetals (TDS, TWS) are materials with **Dirac** (linear, relativistic) dispersion for **3D fermions**:



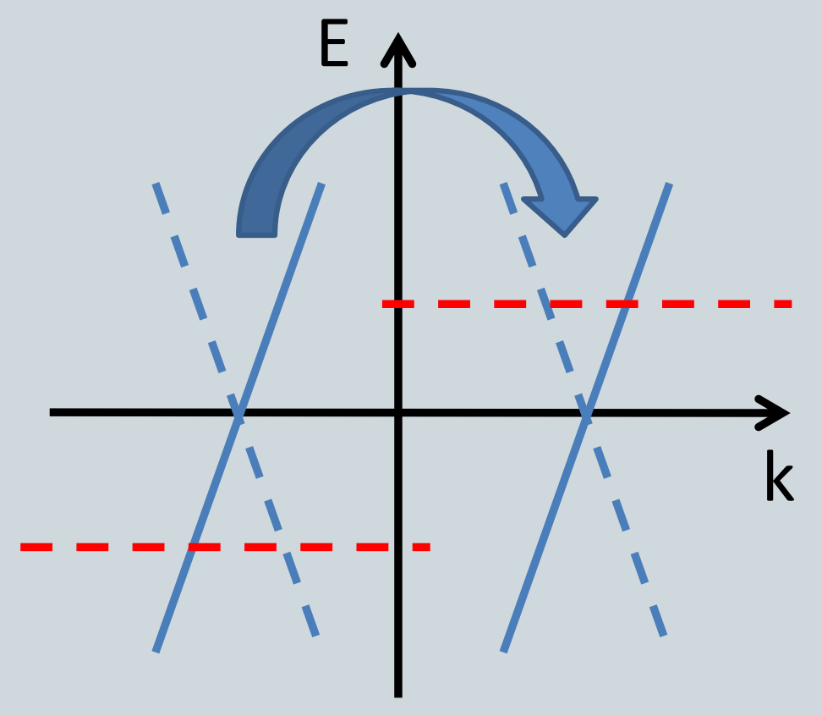
Breaking of time-reversal or inversion **symmetry**

Dirac – single cone

Weyl – two cones of opposite chirality

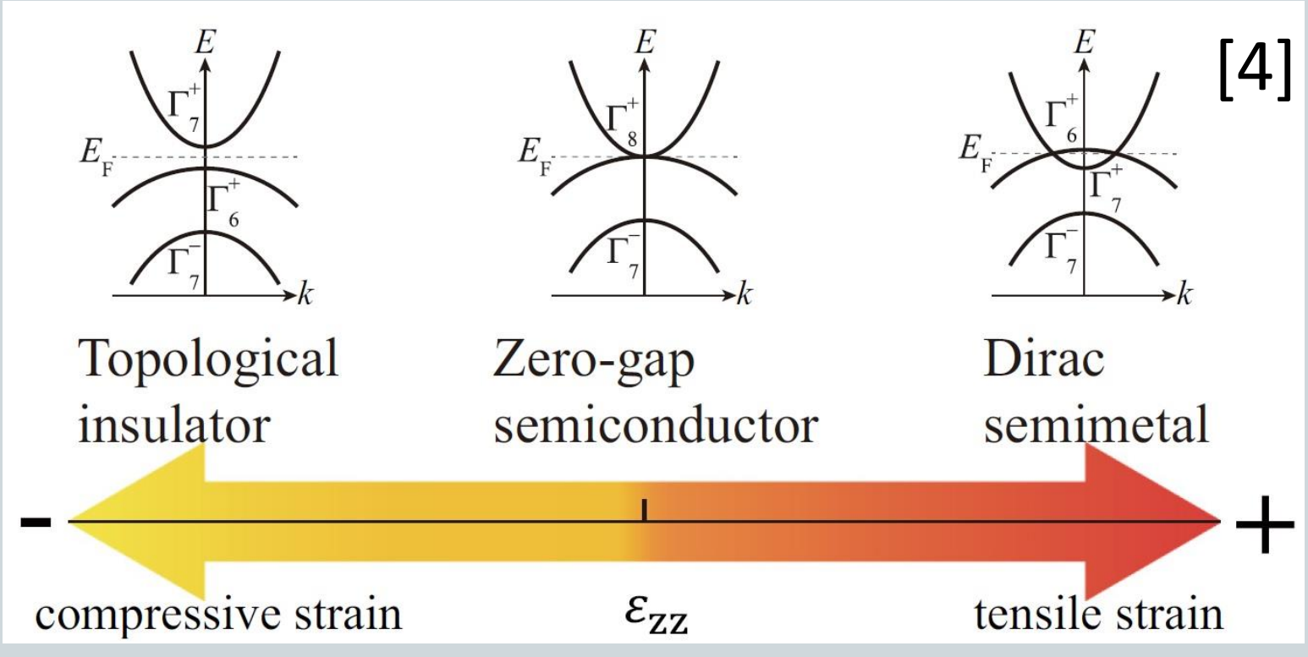
Weyl fermions are subject to **chiral anomaly**:
Negative Longitudinal Magnetoresistance
expected in TDS and TWS [1-3]

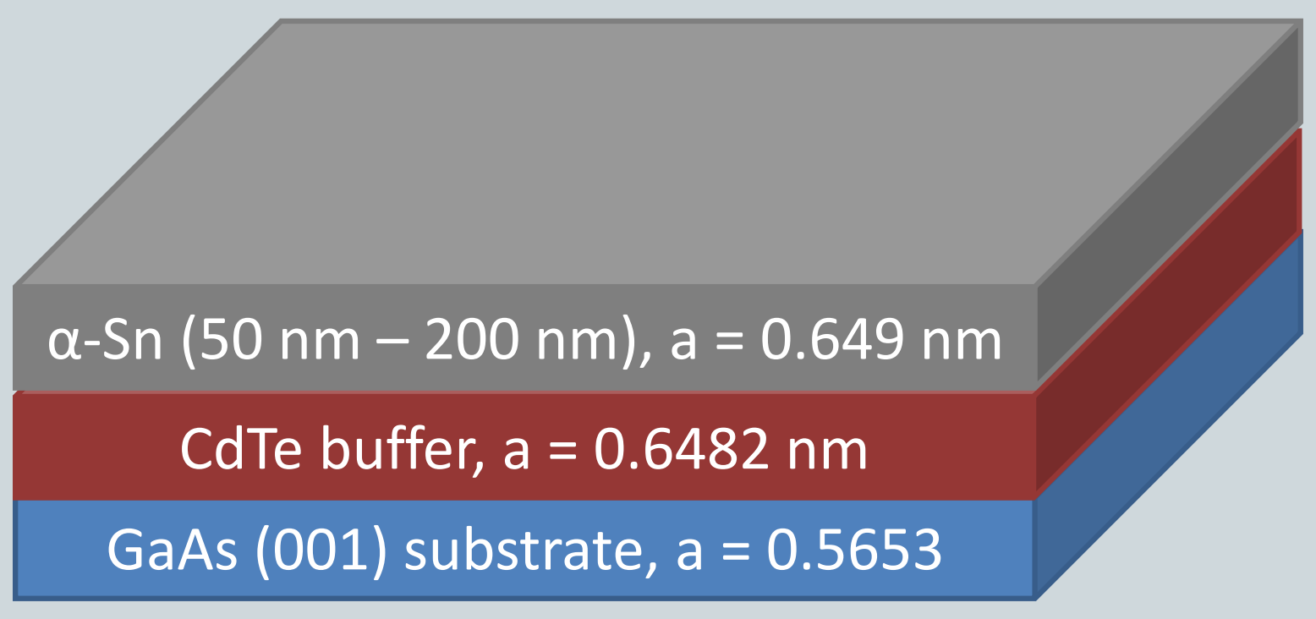
$$\vec{B}||\vec{E} \Rightarrow \rho_{xx} \sim \frac{1}{B^2}$$



MATERIAL AND SAMPLES

α-Sn (grey tin) is a zero-gap semiconductor with the band structure similar to that of HgTe.



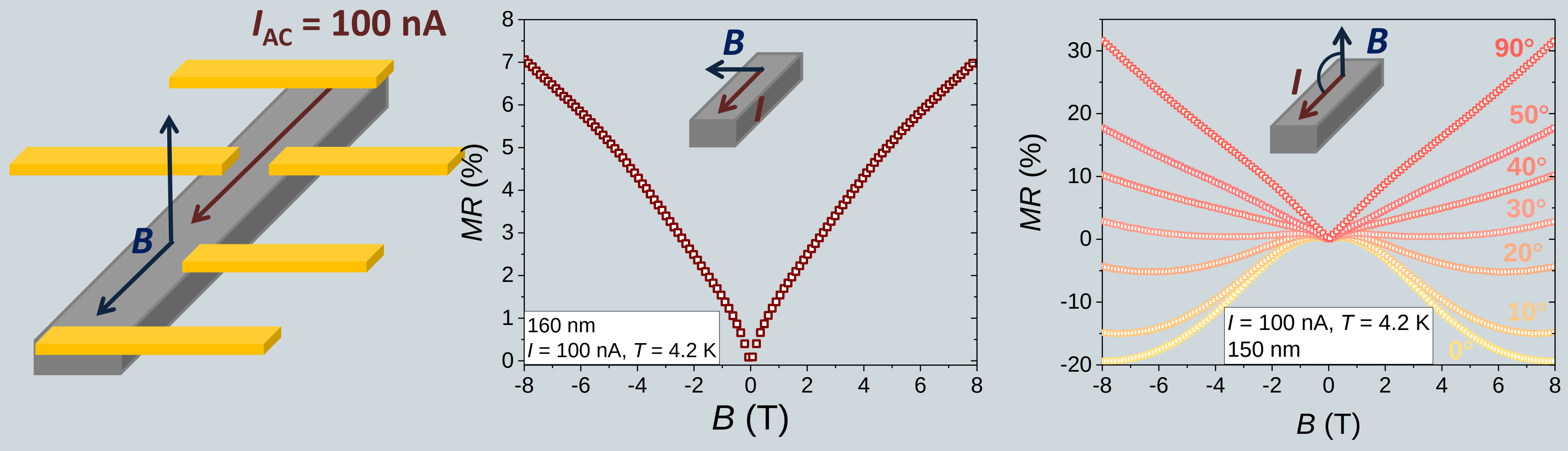


- Topological Insulator/Dirac semimetal phases by **strain engineering**
- Magnetic field breaks TR symmetry: Dirac -> Weyl
- Particle physics and non-trivial topology in a simple, solid state system
- Potential applications e.g. in spintronics [5-7]:

MAGNETOTRANSPORT STUDY

PRELIMINARY RESULTS

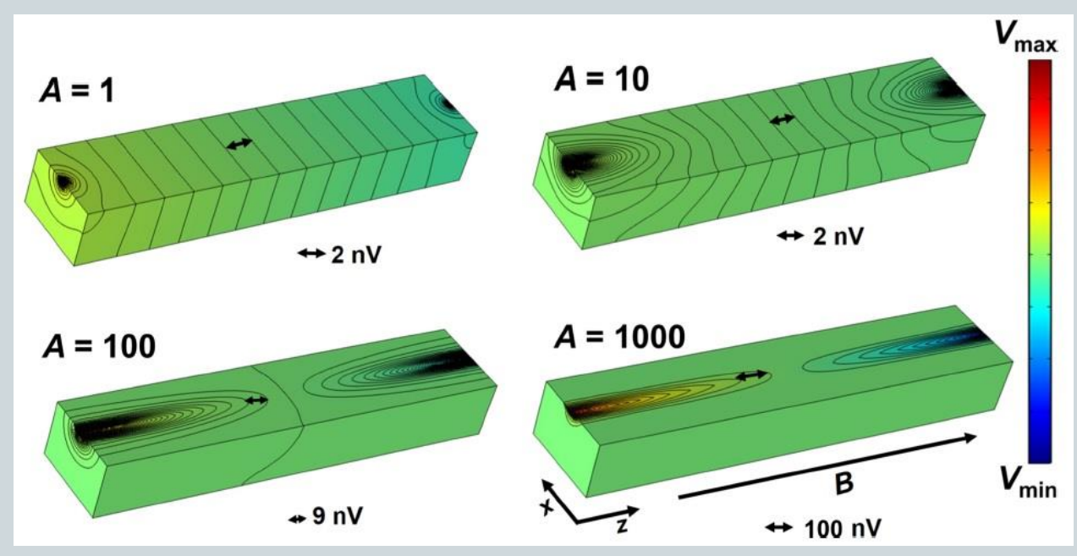
Magnetotransport measurements for *B* = +/- 8 T, *T* = 2.5 K – 120 K



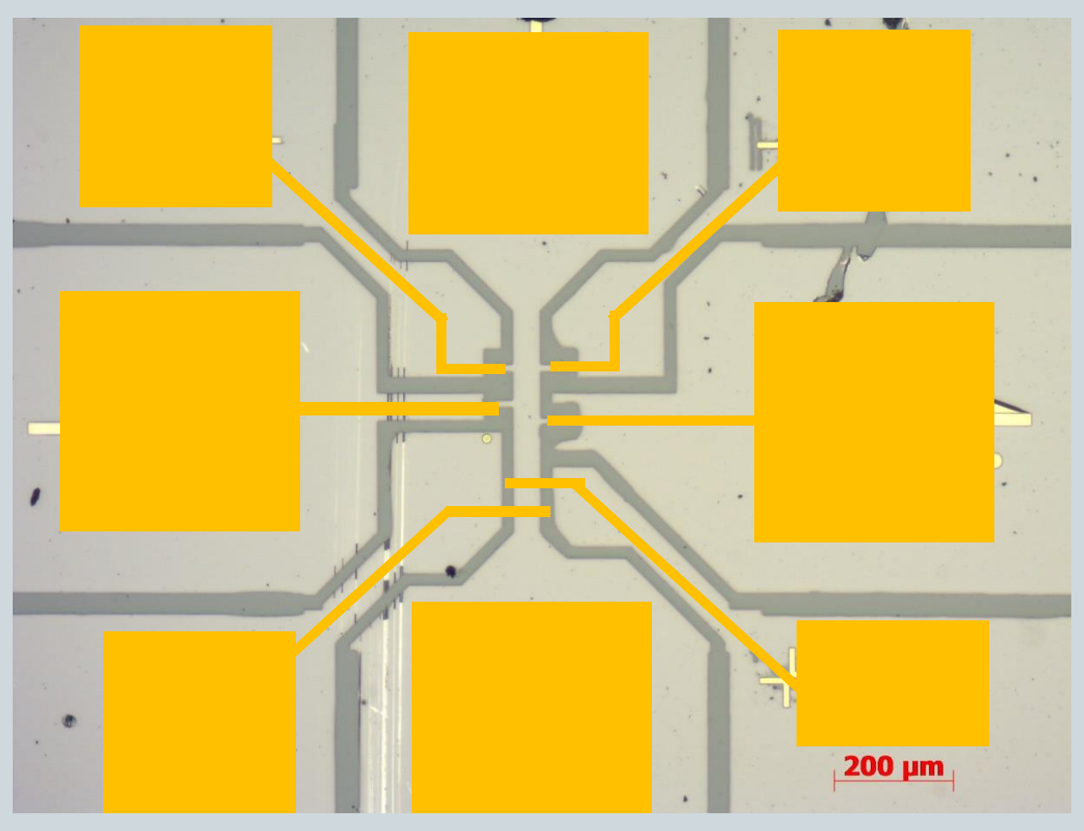
- Positive magnetoresistance for B_{perp}, both in- and out-of-plane
- **NLMR observed** only for B_{paral}, for all samples studied
- Weak-antilocalization-like feature around *B* = 0

IMPROVEMENT – ETCHED SAMPLES

NLMR can be mimicked by parasitic effects (e.g. current-jetting)



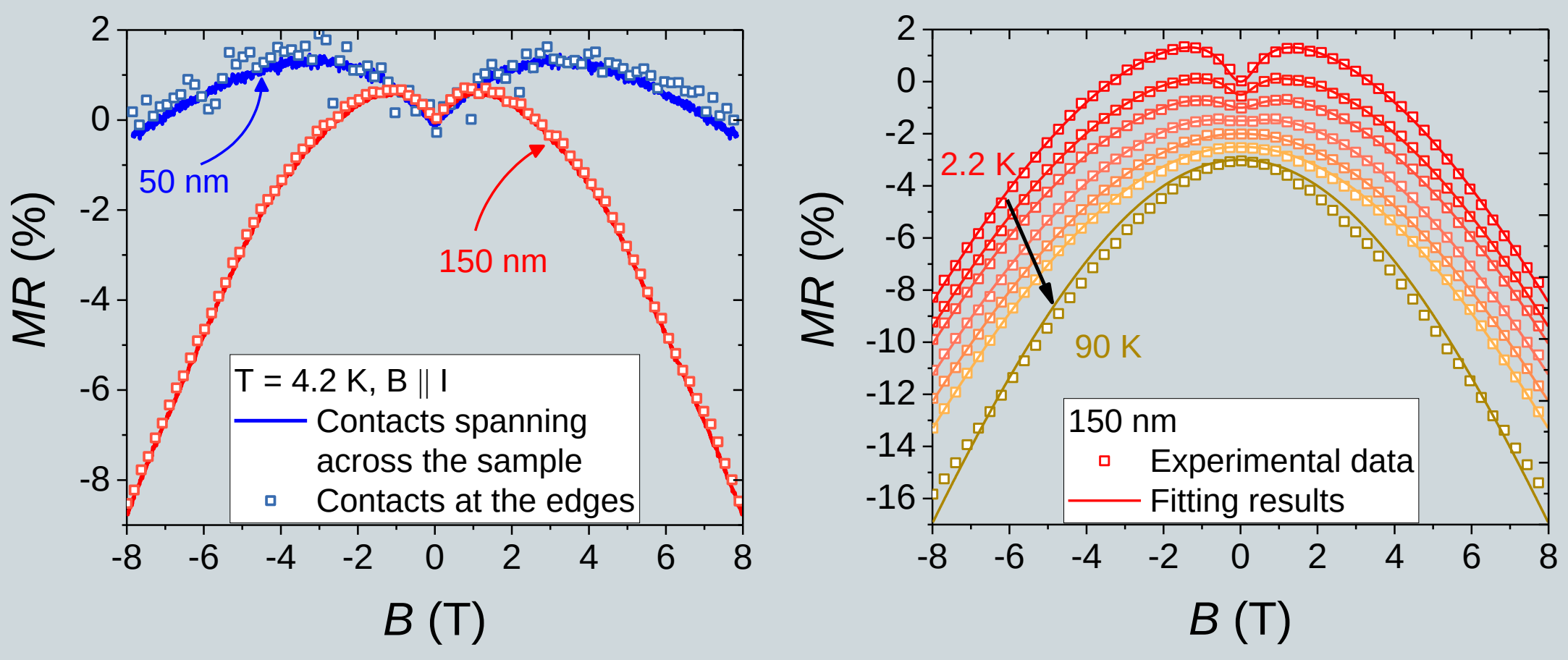
Anisotropy-dependent potential profile [8]



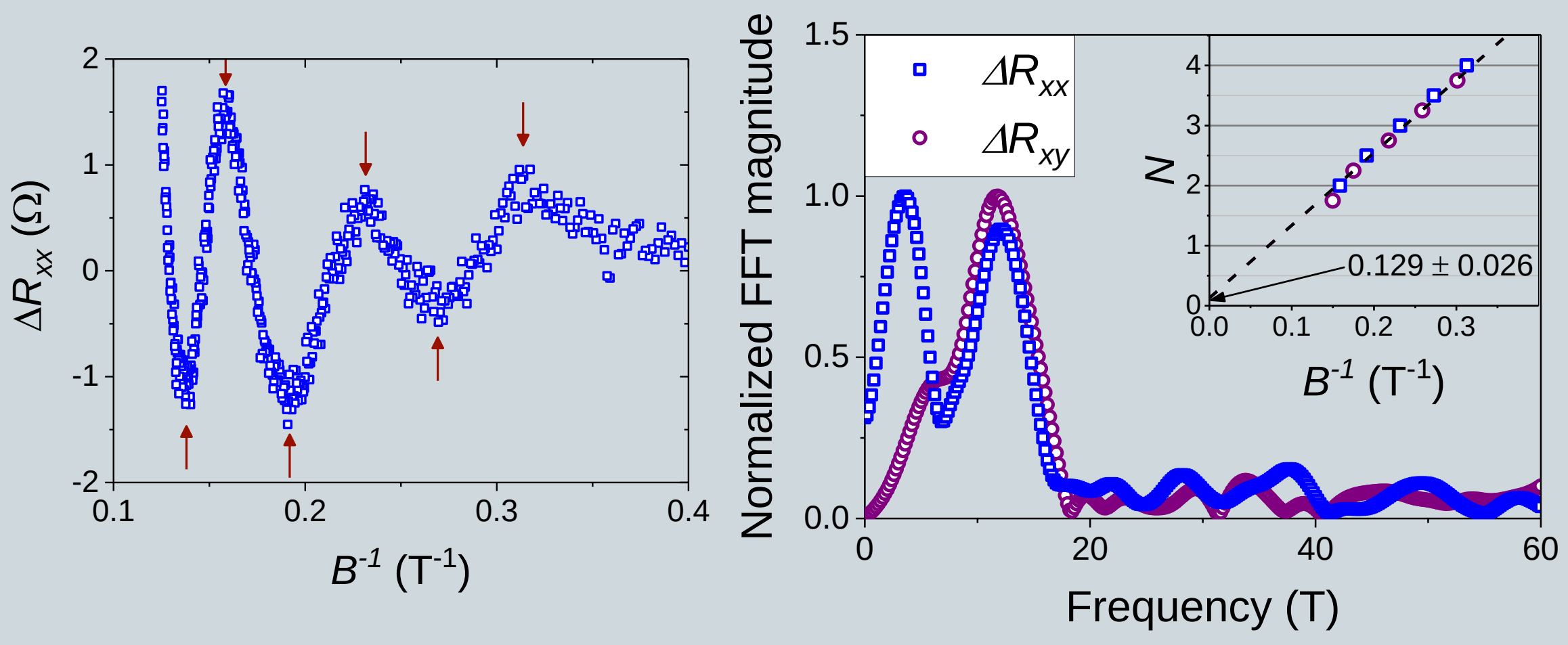
Optical image of the sample taken before metallization

Etched Hallbars (e-beam lithography + etching in HCl) to exclude anisotropy

RESULTS FOR ETCHED SAMPLES



Studies of NLMR
Fitting of $1/B^2$ dependence (including WAL [9])



Analysis of oscillations in 150 nm film, B_{perp}

CONCLUSIONS AND PROSPECTS

- NLMR doesn't depend on contact geometry – current-jetting excluded
- It follows **$1/B^2$ dependence** up to 90 K
- **Shubnikov-de Haas** oscillations indicate *trivial* Berry phase
- Coexistence of trivial and non-trivial carriers

Further studies:

- Higher fields, lower temperatures – **more insight into SdH oscillations**
- **Angle-dependence** of NLMR and SdH oscillations
- Thickness-dependence, channel width-dependence

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