

Non-equilibrium magneto-resistance of GeAu

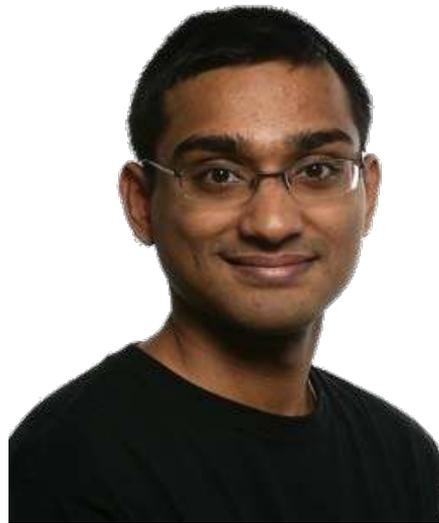
Gareth Conduit
James Dann
Vijay Narayan
Philipp Verpoort

Theory of Condensed Matter & Semiconductor Physics

Collaborators



James Dann

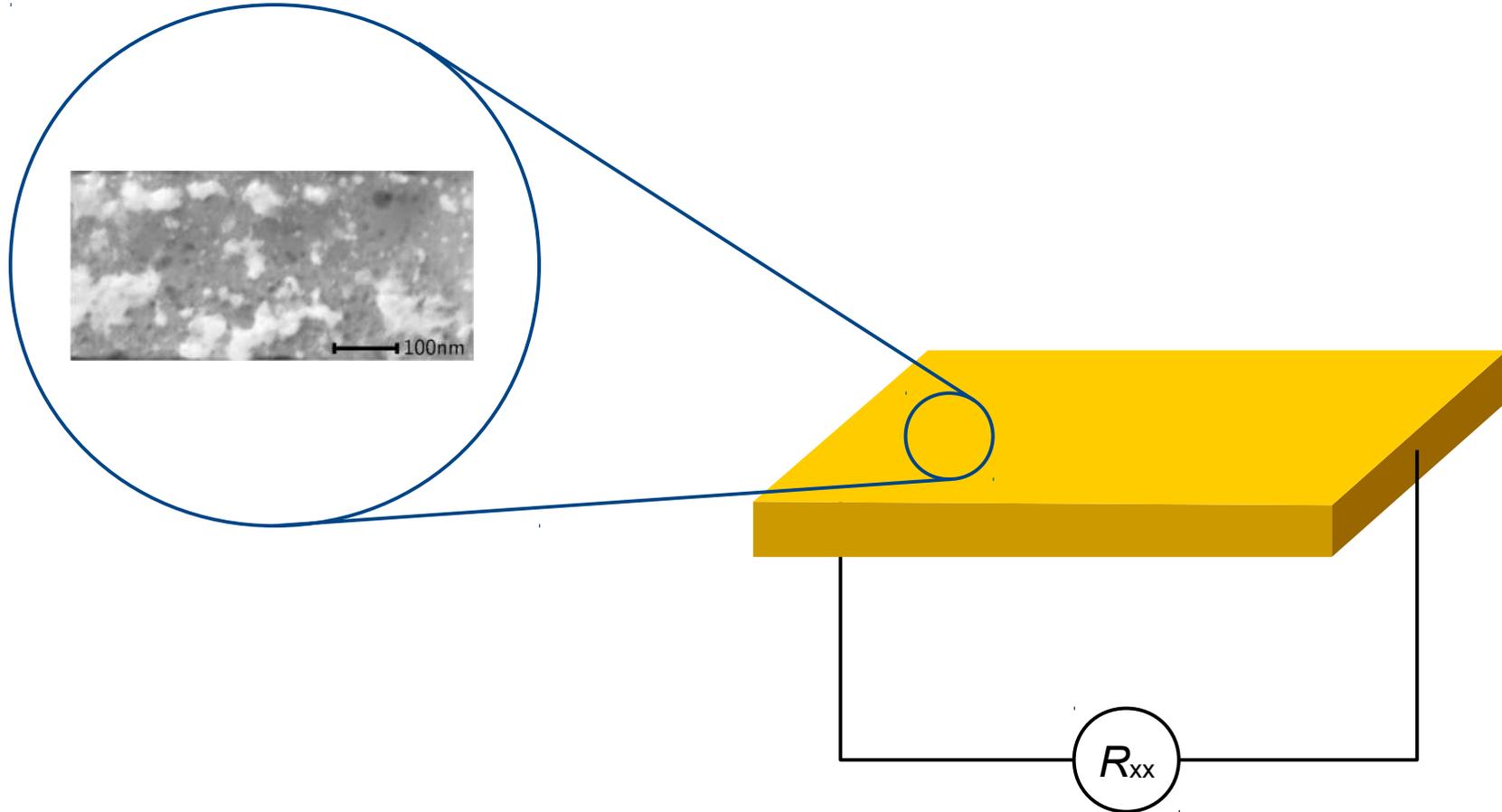


Dr Vijay Narayan

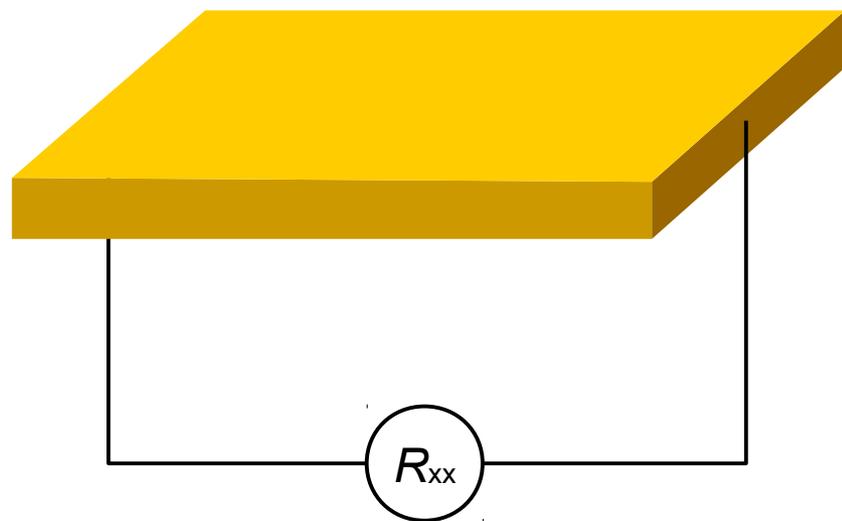
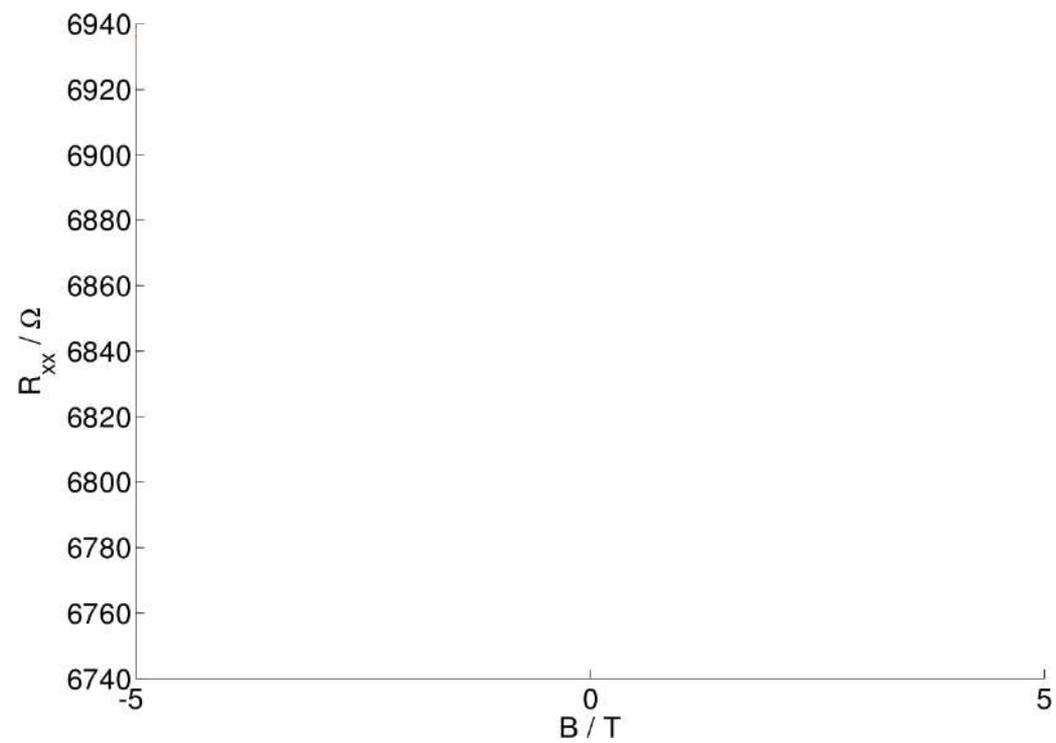


Philipp Verpoort

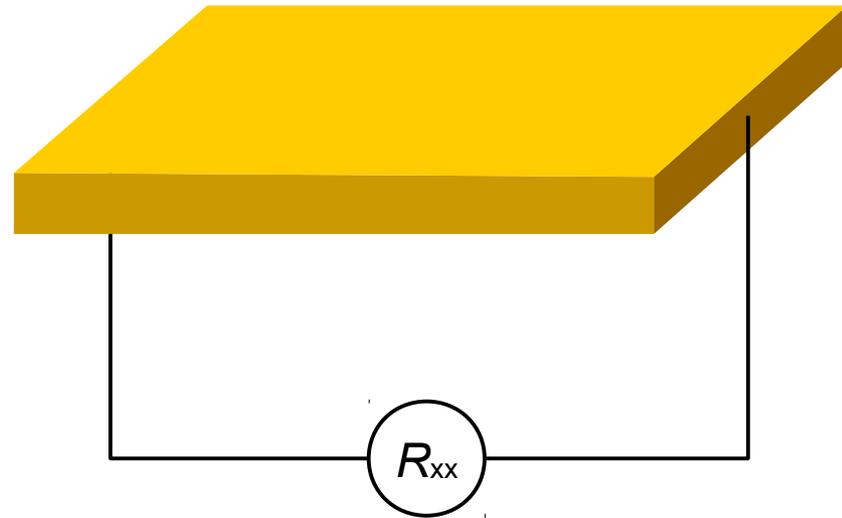
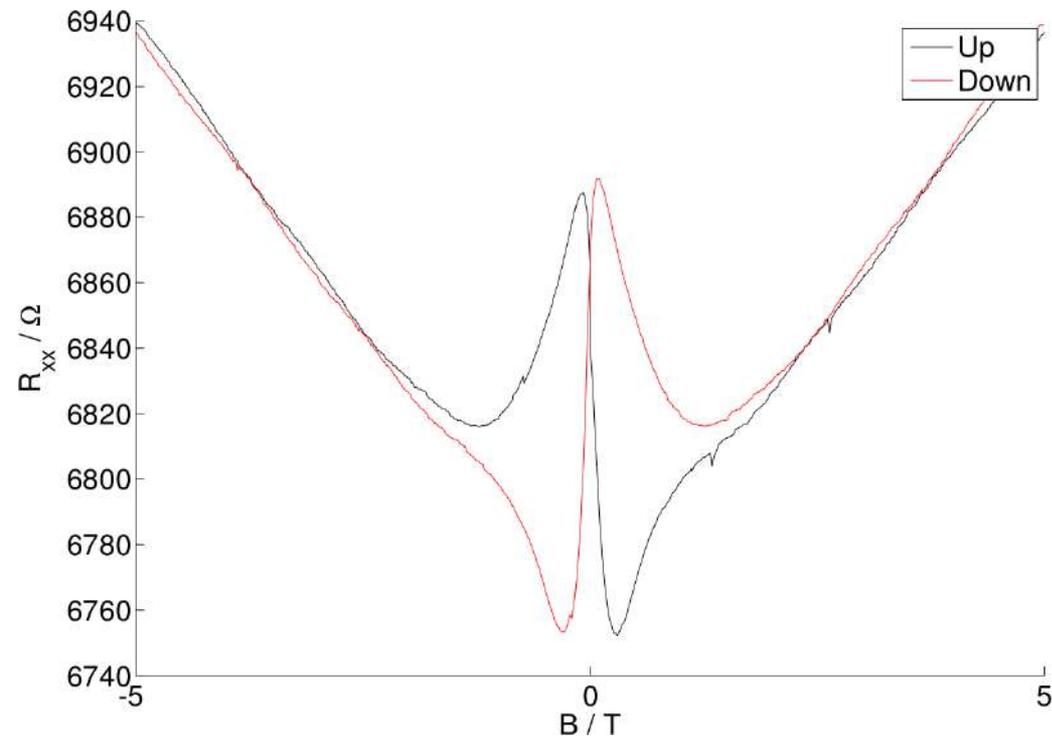
Setup: $\text{Ge}_{0.9}\text{Au}_{0.1}$



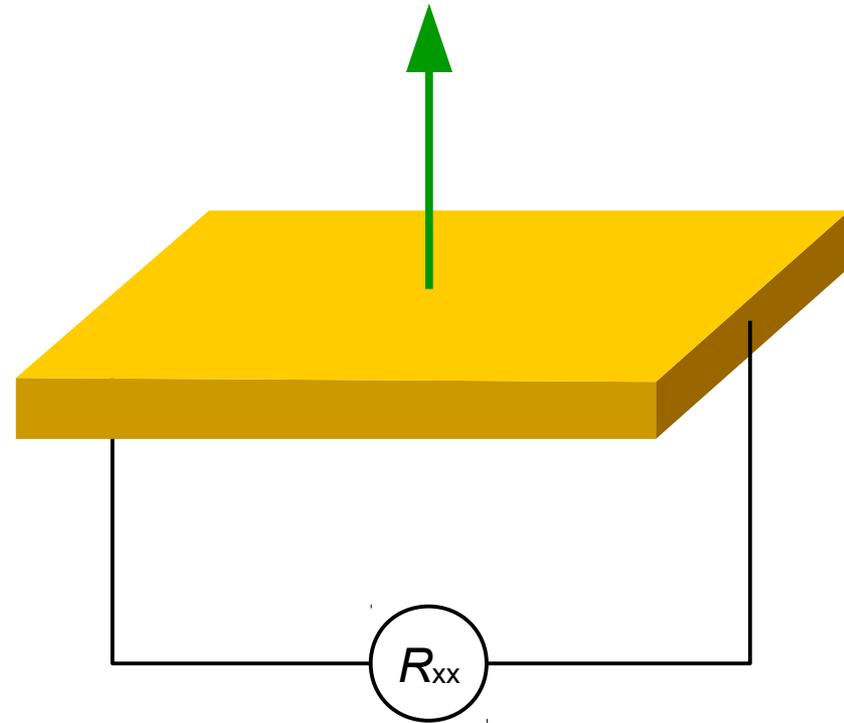
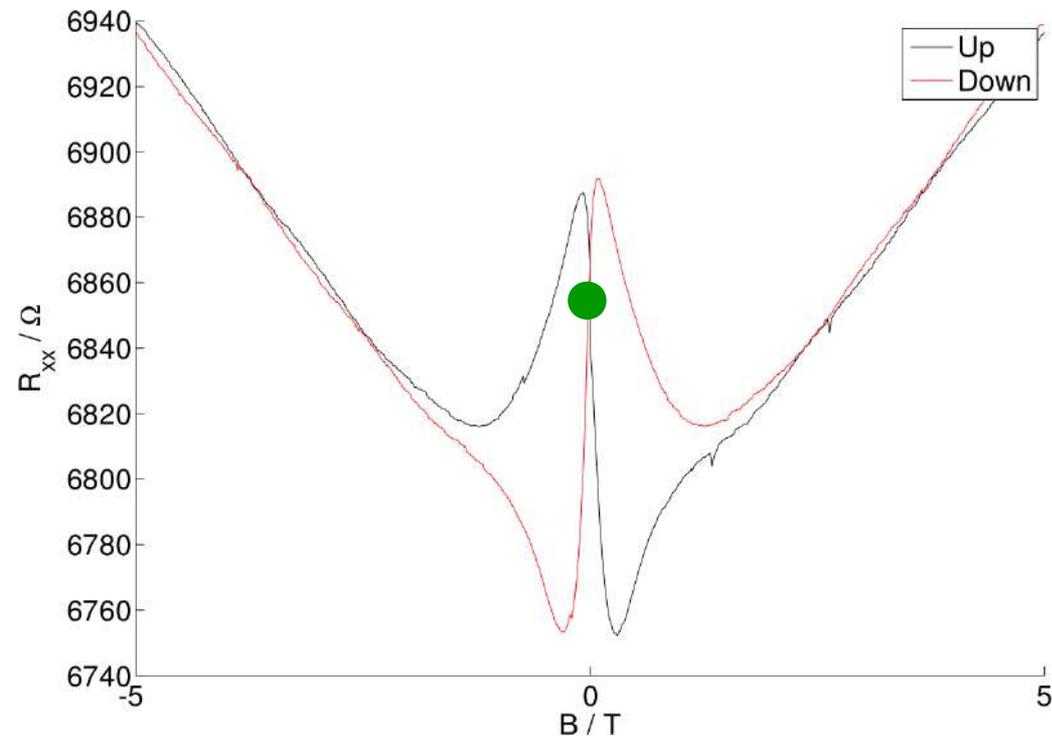
Setup: GeAu



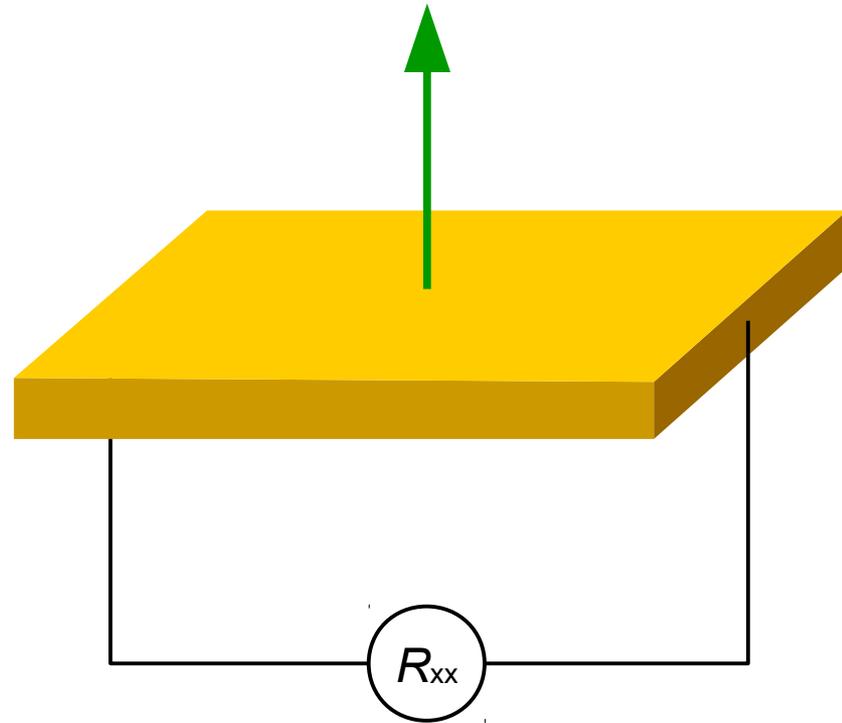
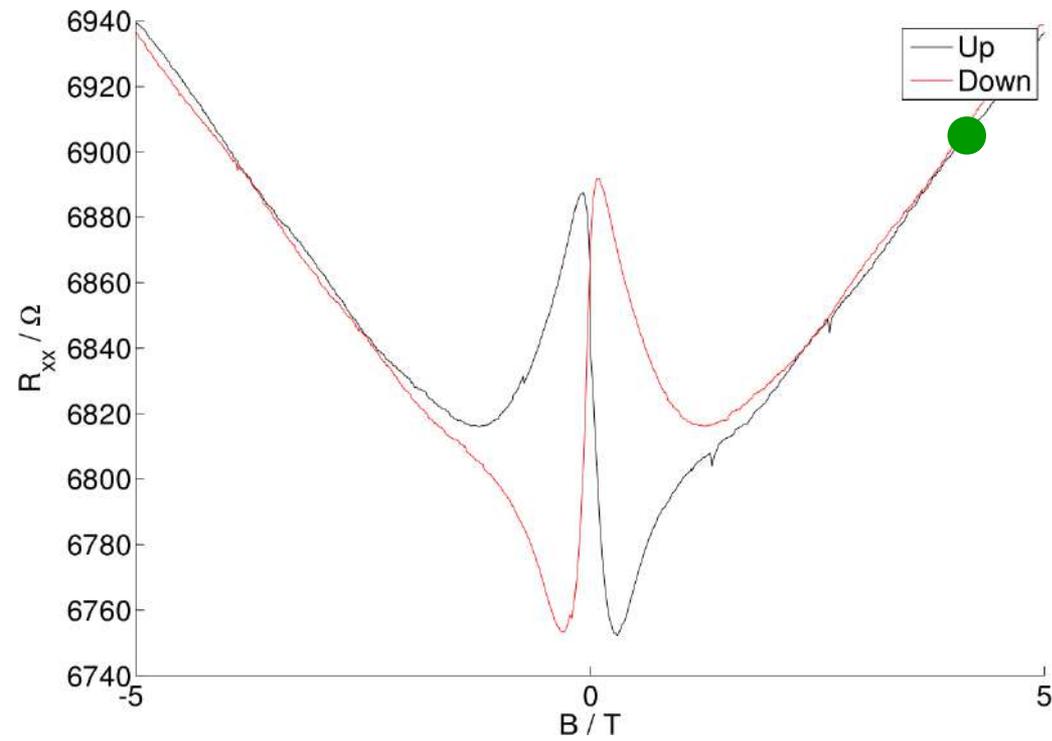
Apply a magnetic field



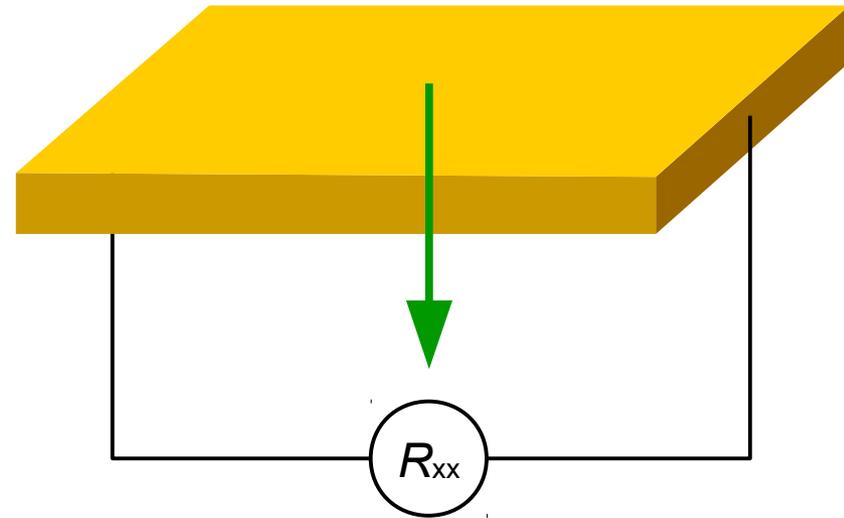
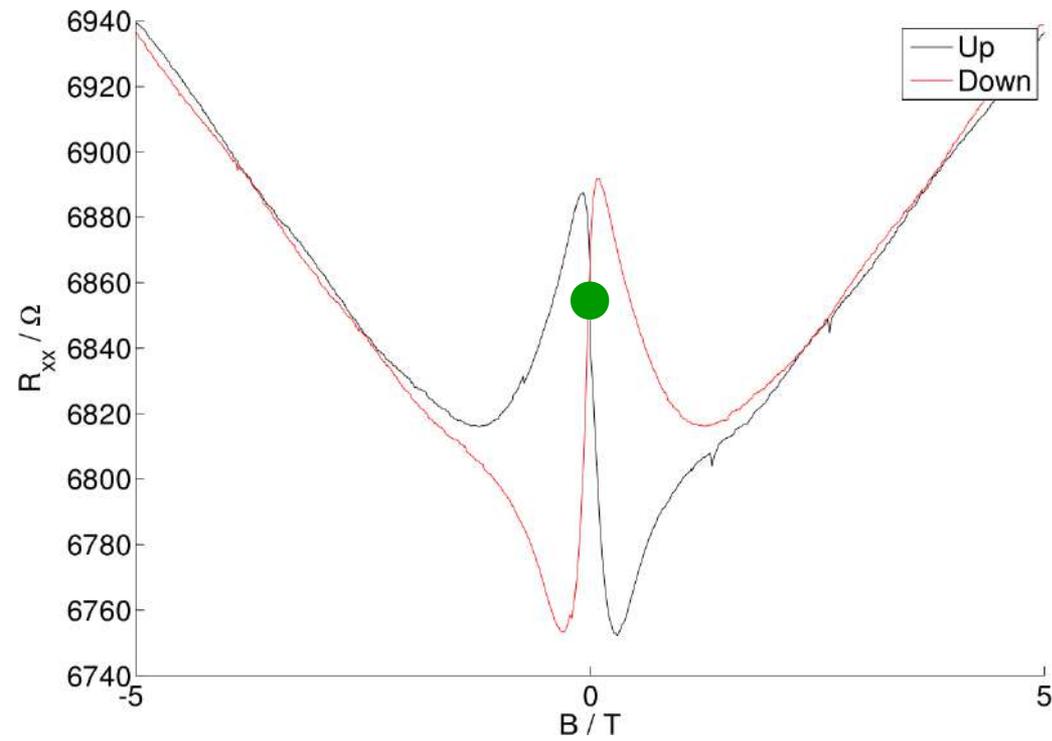
Increase magnetic field



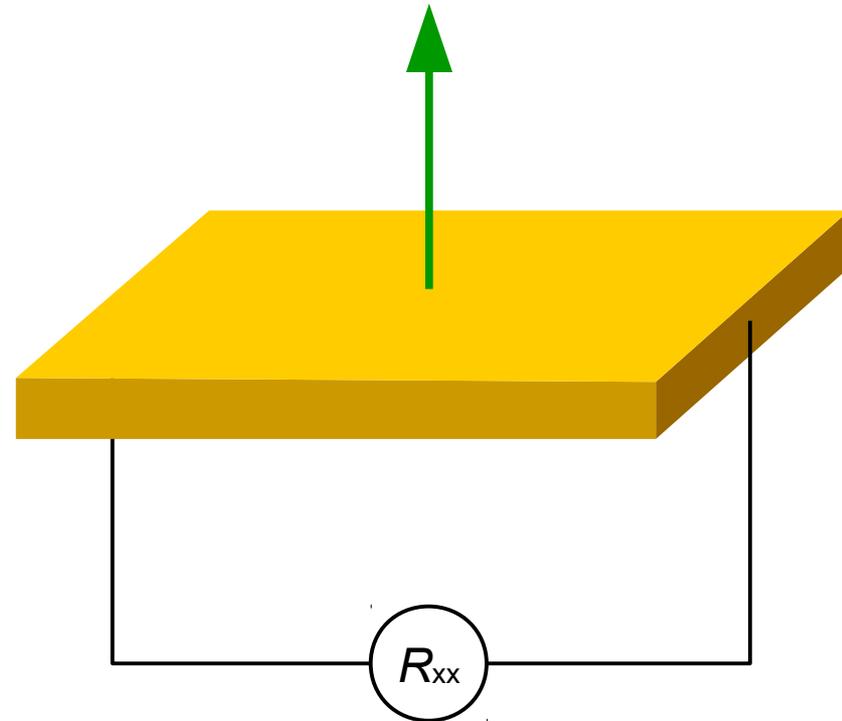
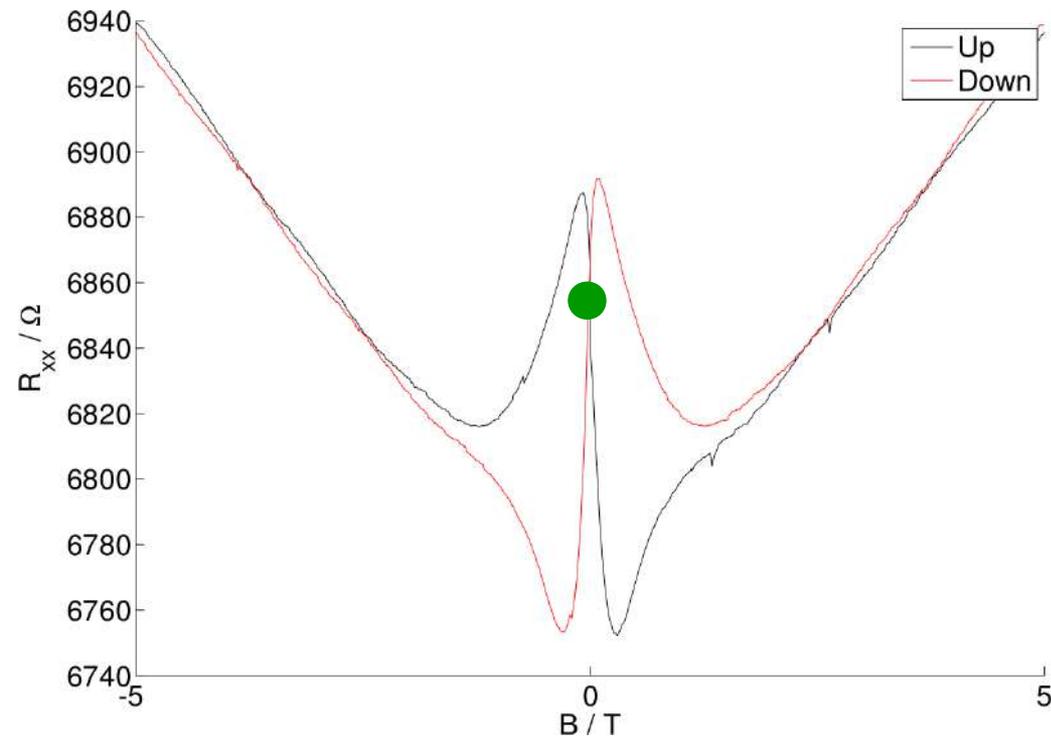
Decrease magnetic field



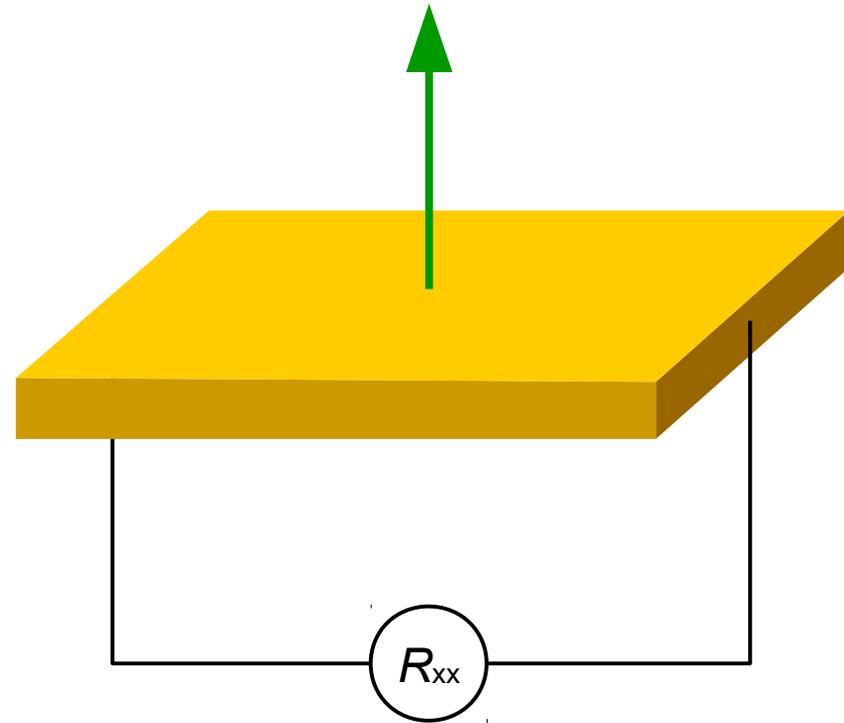
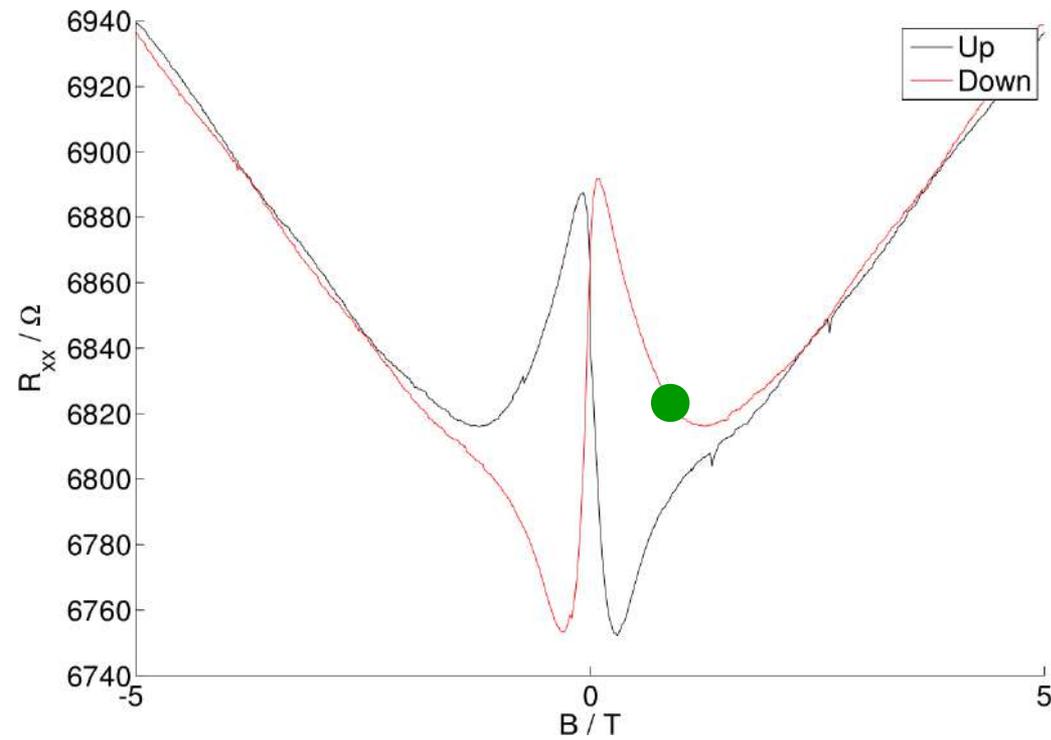
Negative magnetic field



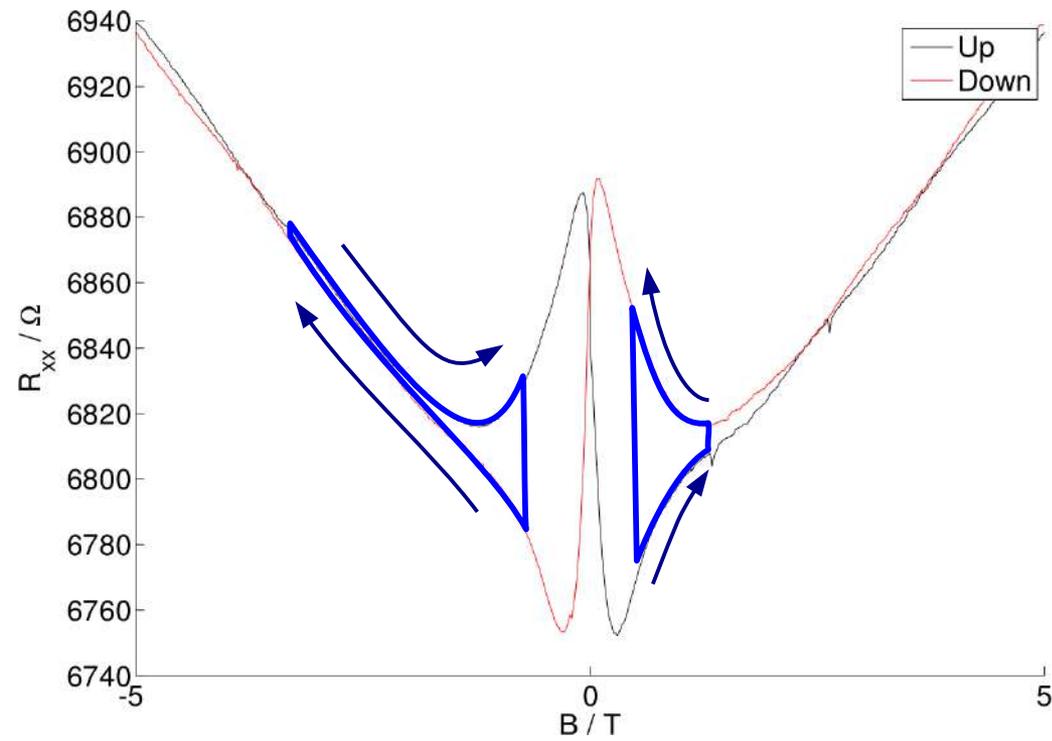
Small increasing magnetic field



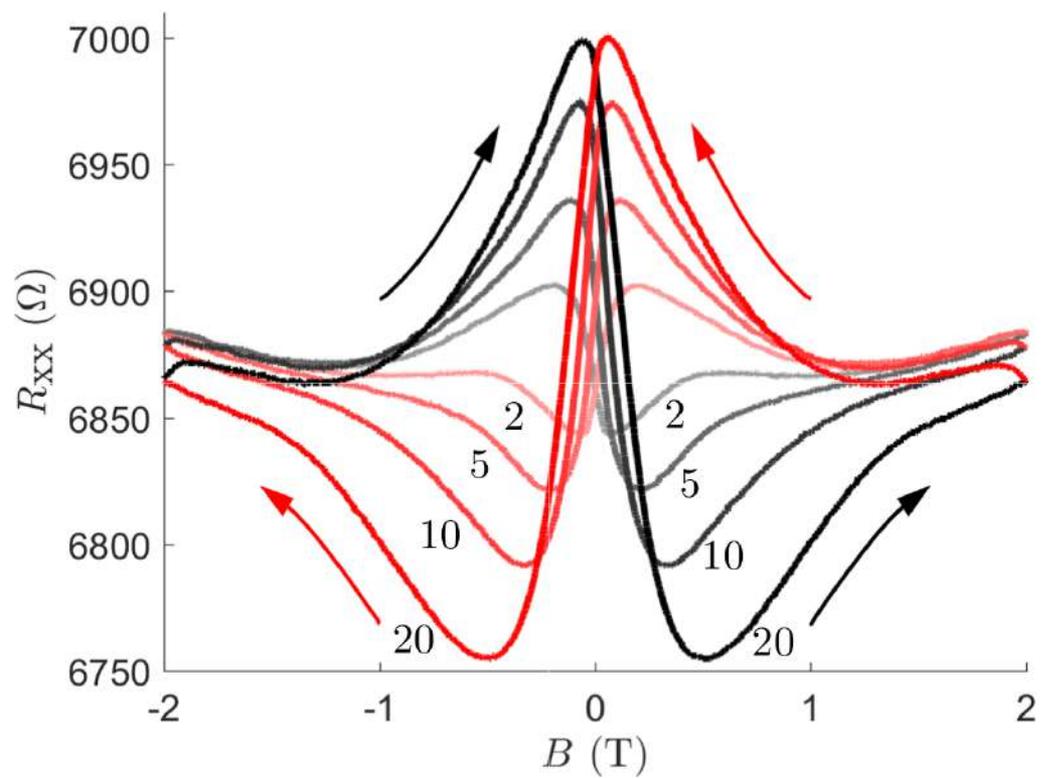
Small decreasing magnetic field



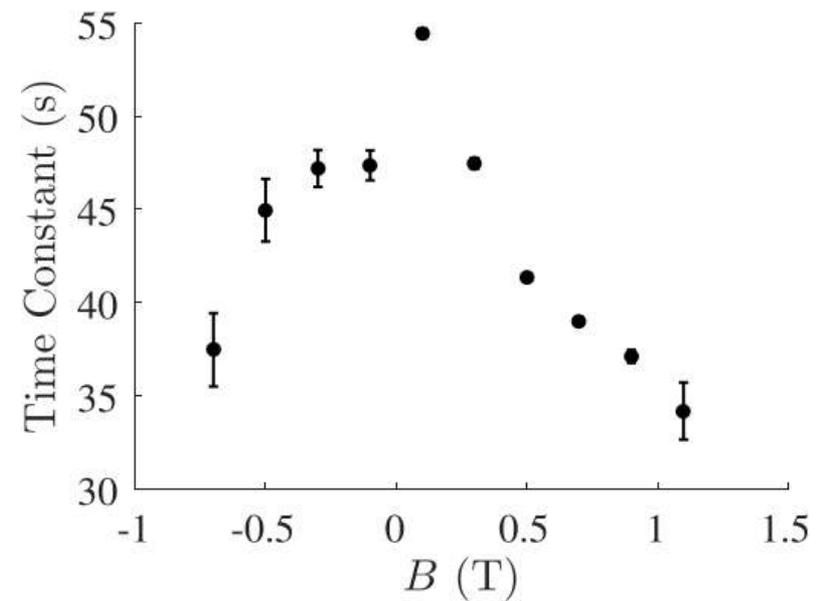
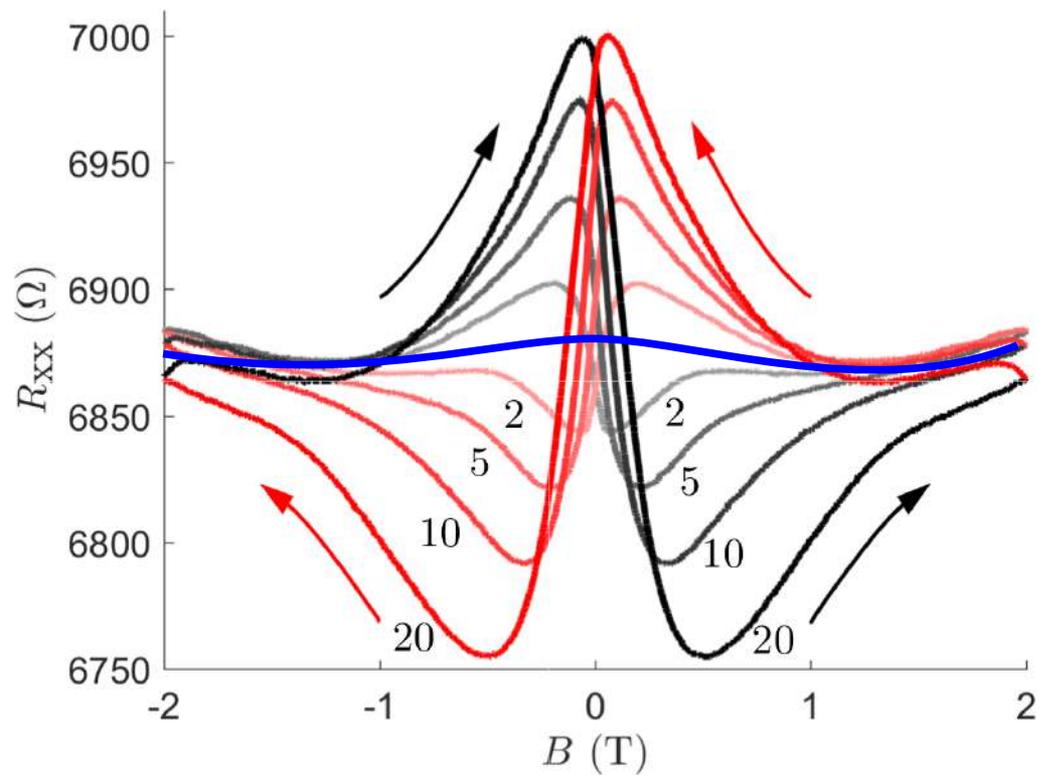
Possible loops



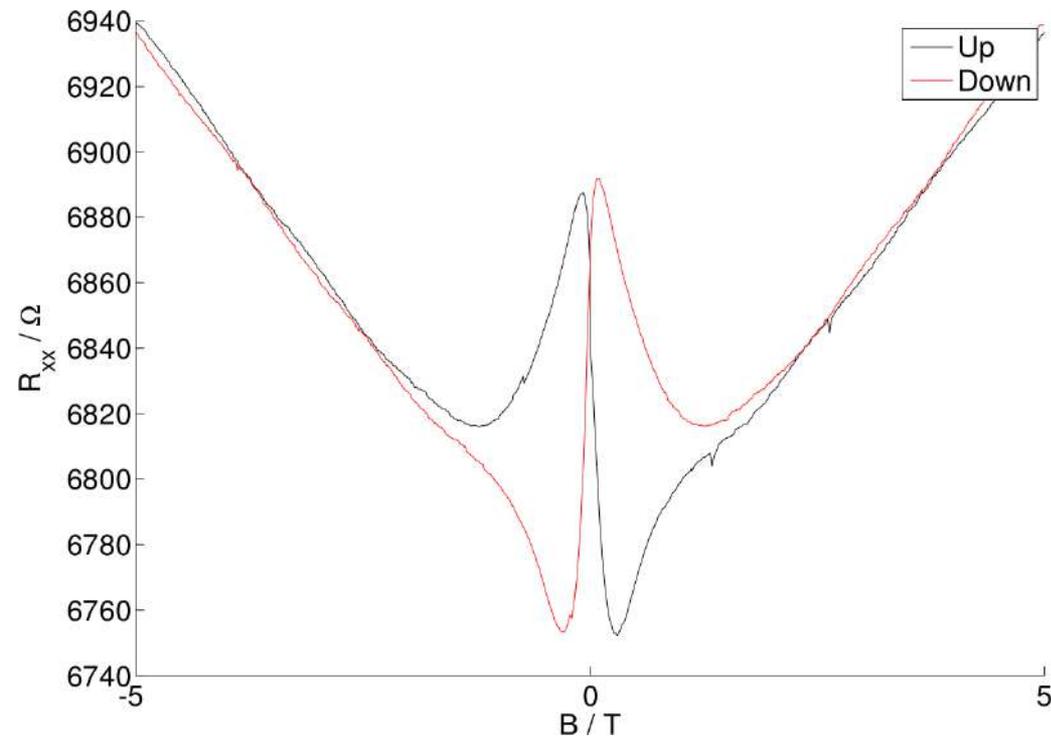
Changing dB/dt



Relaxation time

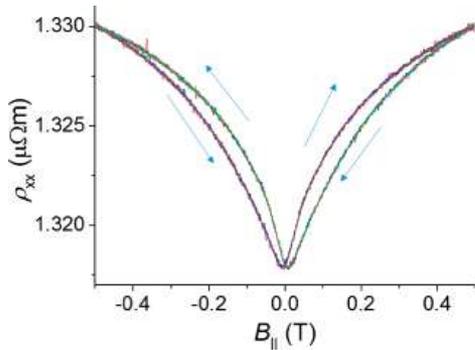


Summary of observations

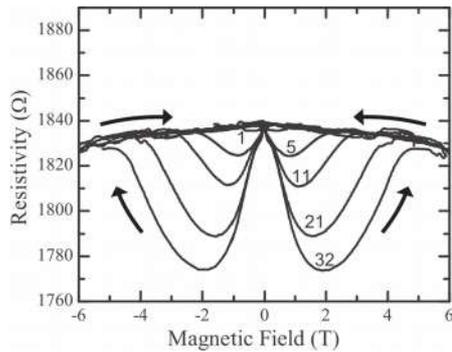


GeAu displays hysteresis
Depends on B and dB/dt
Antisymmetric around $B=0$

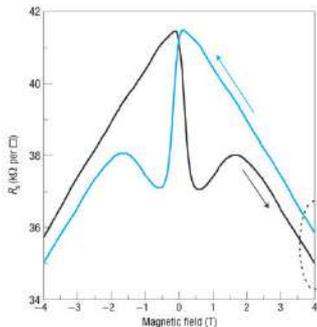
Observation in thin film systems



GeTe *physica status solidi* **10**, 253 (2016)



SmB₆ *PRB* **92**, 115110 (2015)



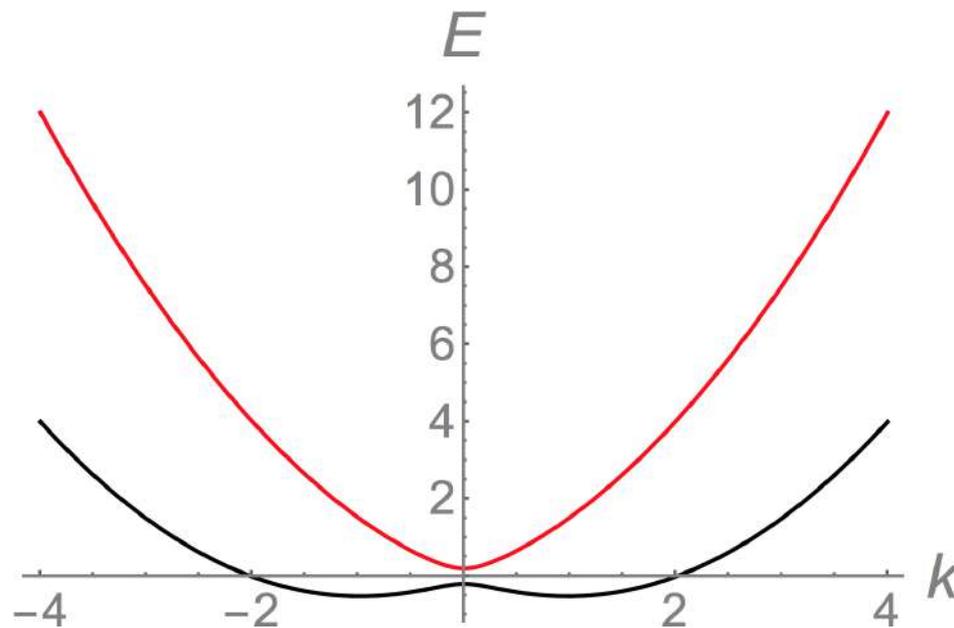
SrTiO₃-LaAlO₃ *Nature Mat.* **6**, 493 (2007)

Hamiltonian

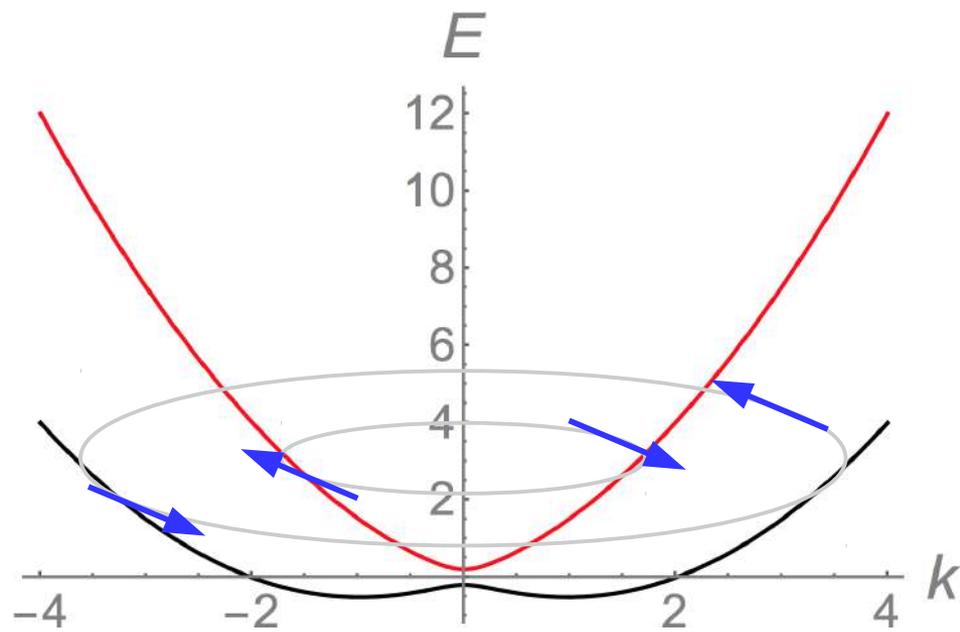
$$\hat{H} = \frac{k^2}{2m} - \gamma(k_y \sigma_x - k_x \sigma_y)$$

Energy dispersion

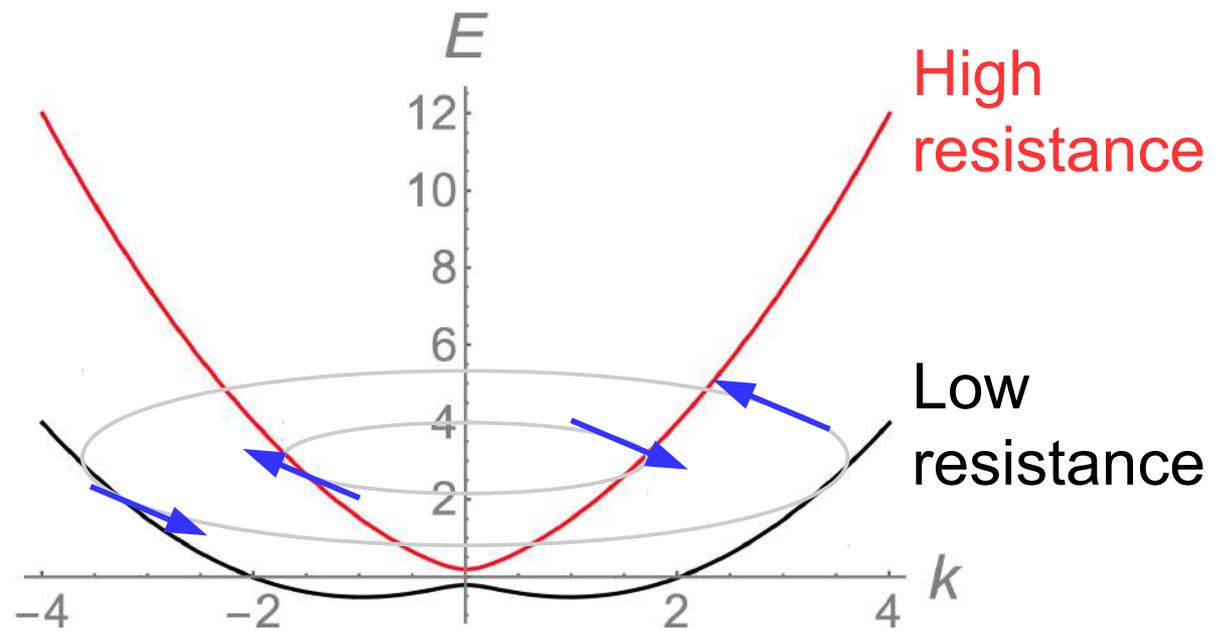
$$\hat{H} = \frac{k^2}{2m} - \gamma(k_y \sigma_x - k_x \sigma_y)$$



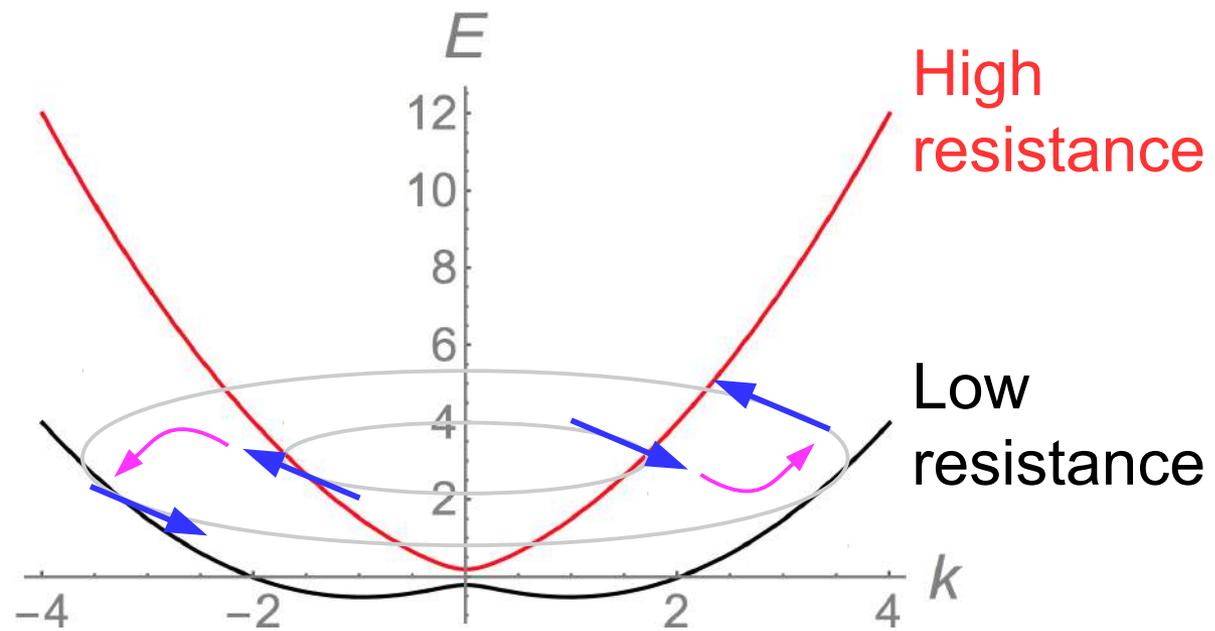
Energy dispersion



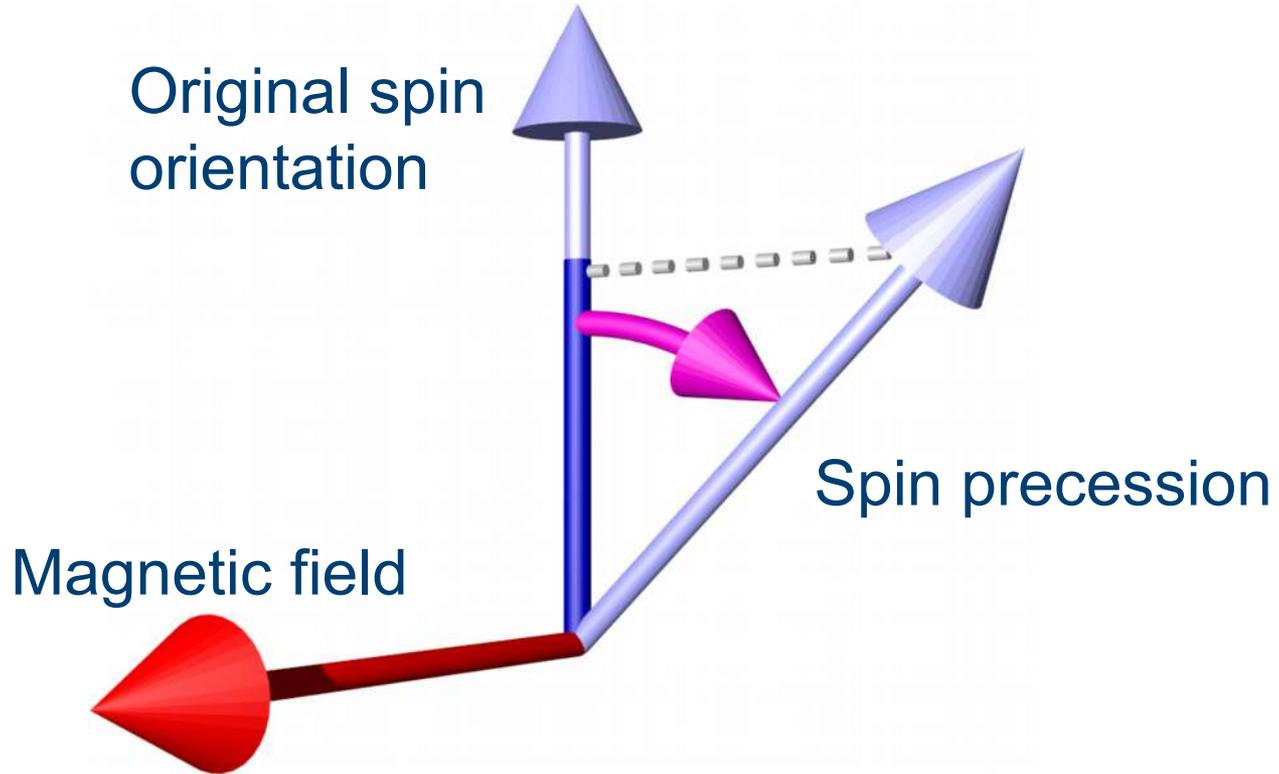
Energy dispersion



Resistance of the dispersion

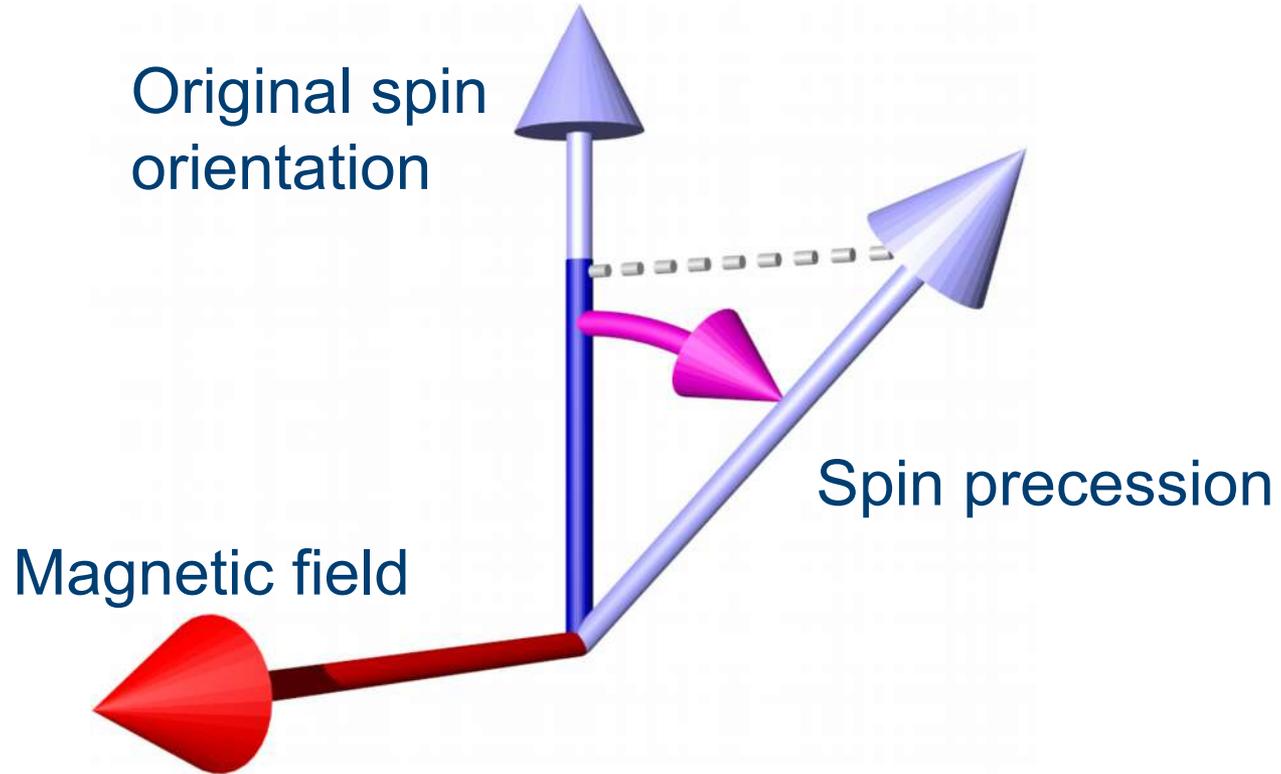


Spin precession



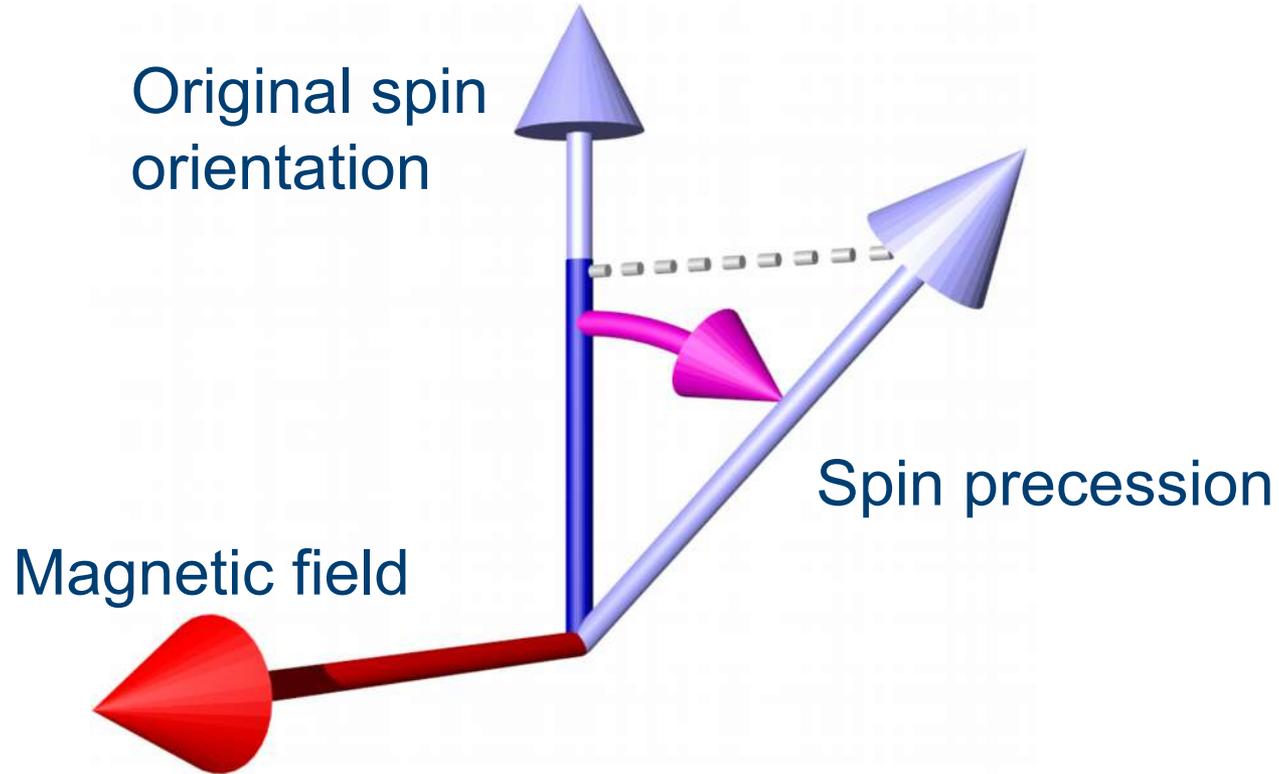
$$\hbar \frac{d\mathbf{n}}{dt} = \mathbf{n} \wedge (\mathbf{B} + \Delta)$$

Spin precession



$$\dot{n} = -\frac{B_{\perp} \dot{B}_{\perp}}{\Delta^2} n$$

Spin precession

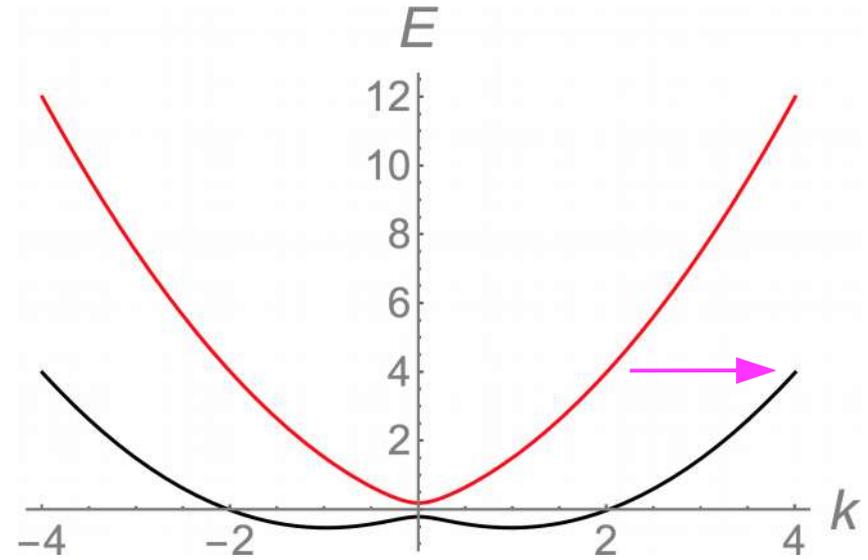
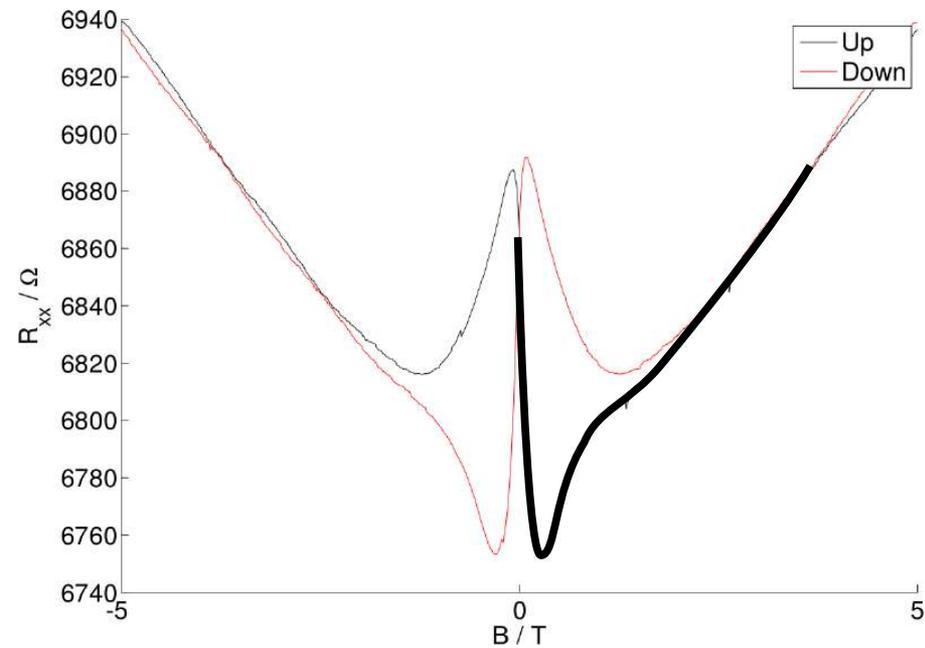


$$\dot{n} = -\frac{B_{\perp} \dot{B}_{\perp}}{\Delta^2} n$$

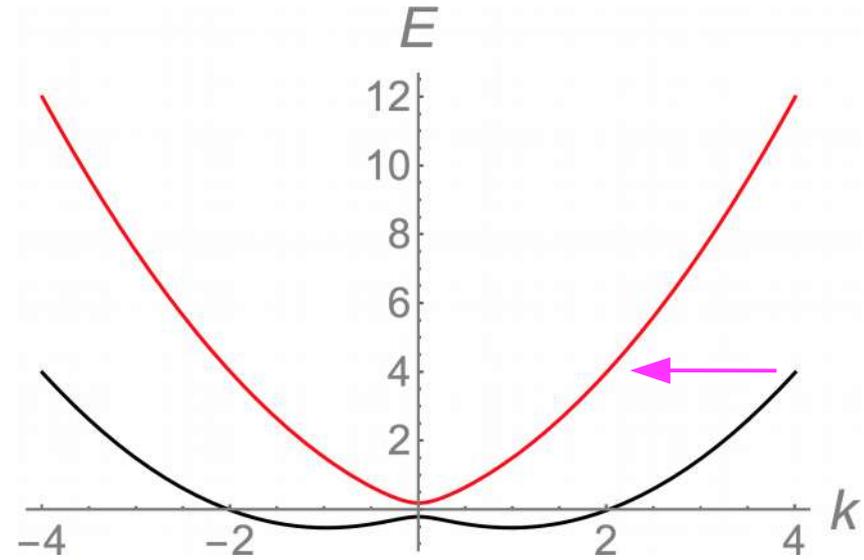
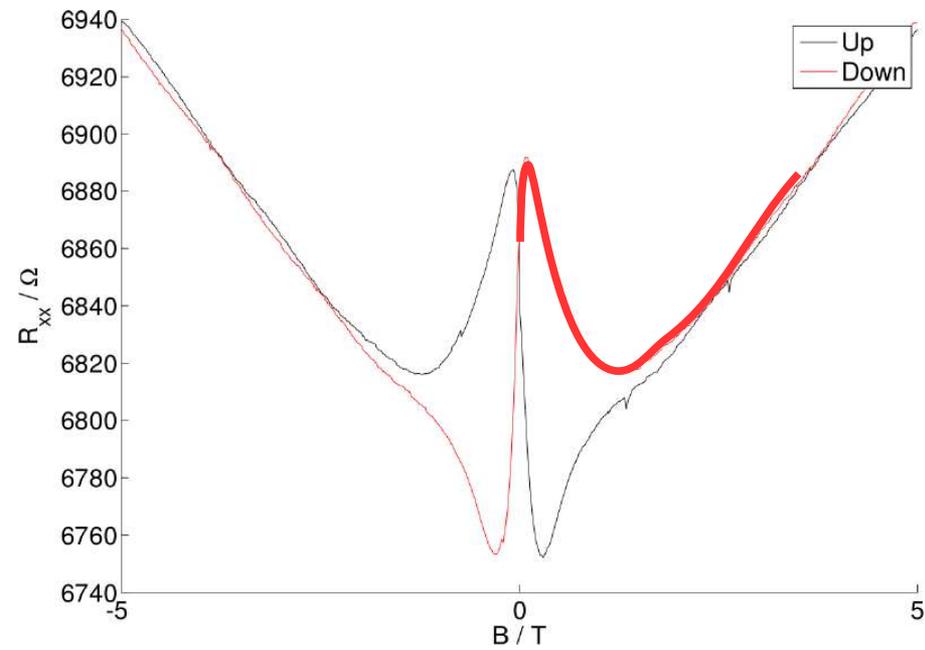
analogous result found
for electric field in
PRL 126603, 92 (2004)

$$\dot{n} = -\frac{E_{\perp} \dot{E}_{\perp}}{\Delta^2} n$$

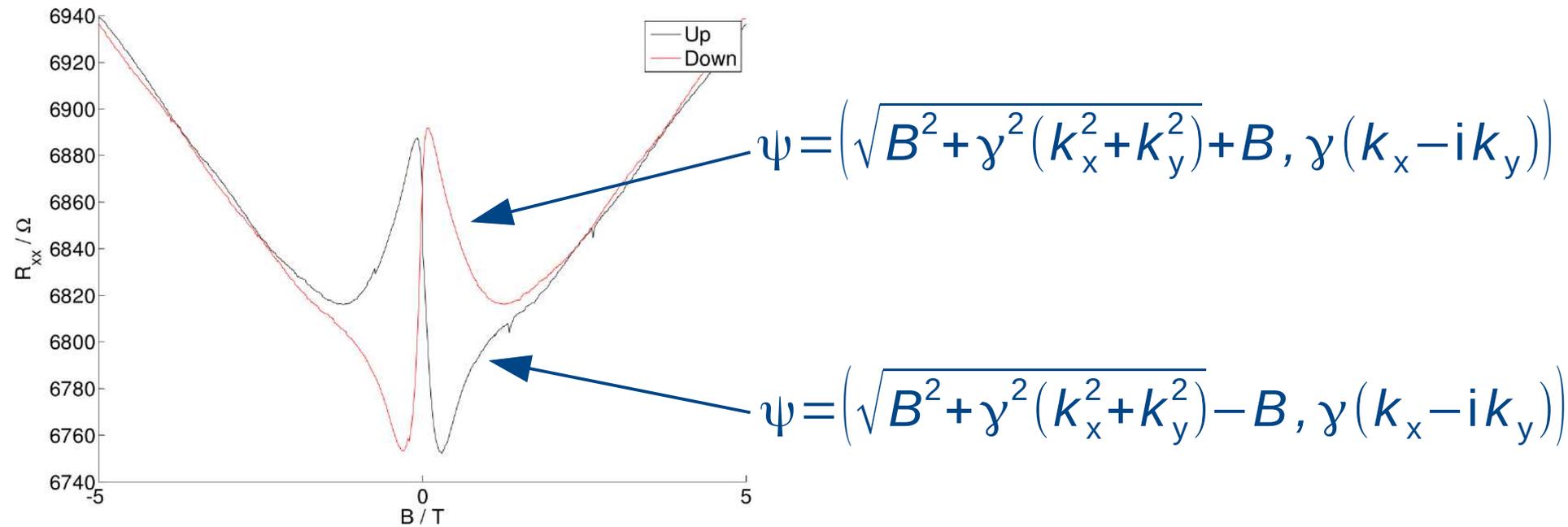
Increasing B lowers resistance



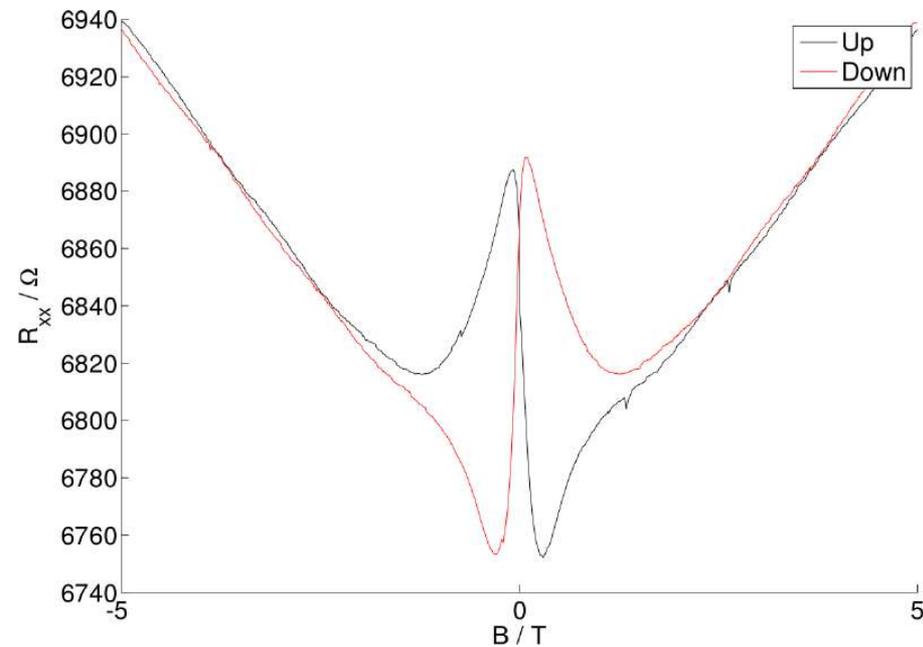
Reducing B increases resistance



Spin orbit physics: flipping the sign of B



Magnetohysteresis / magnetocaloric effect?



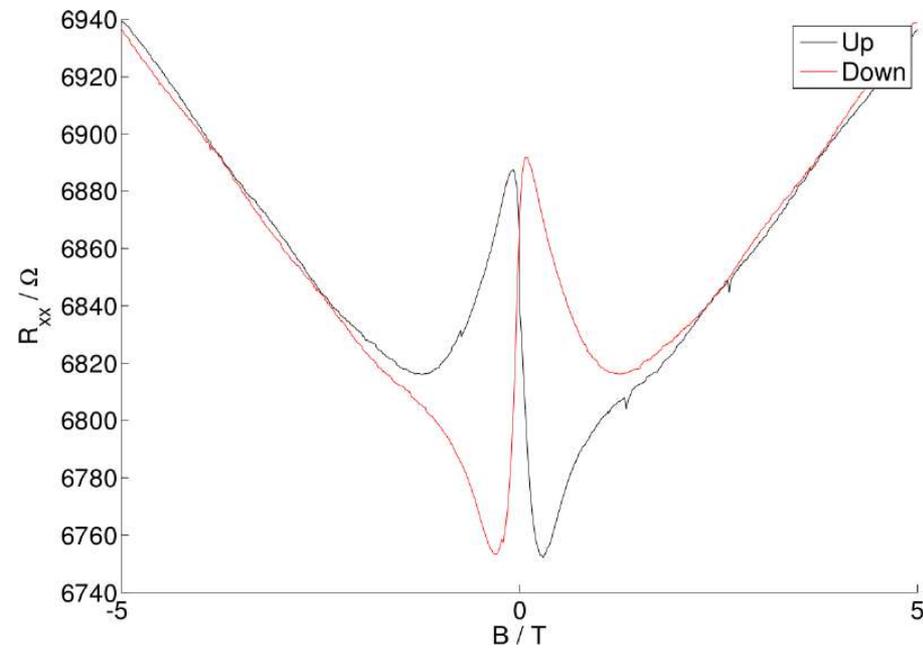
Switches between branches independent of B

Effect resumes after heating to 5K and cooling

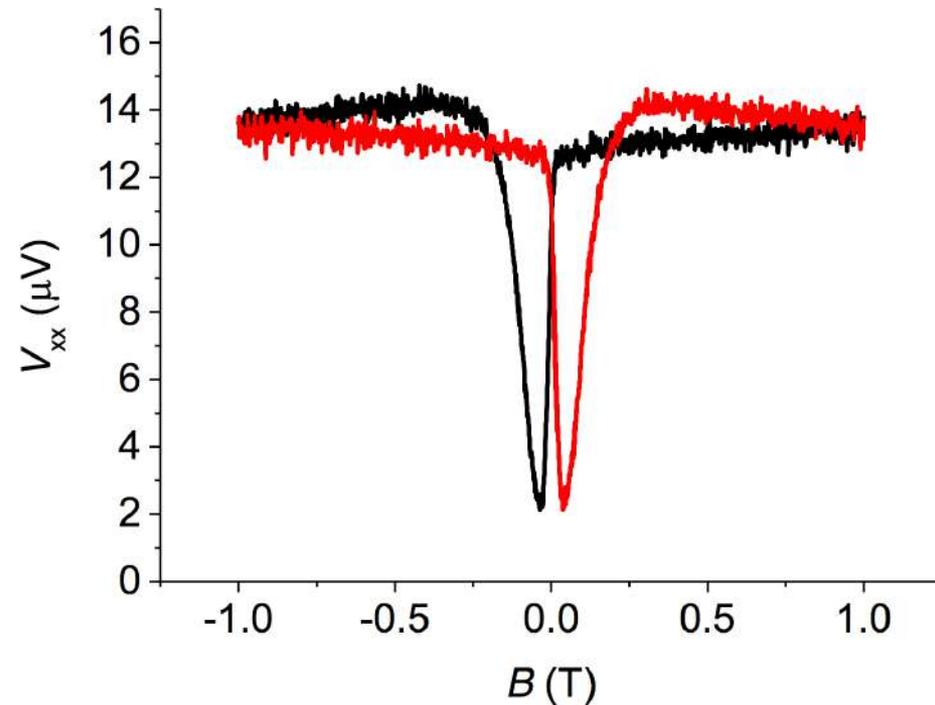
Flipping at $B=0$

Spin orbit physics: superconductivity in GeTe

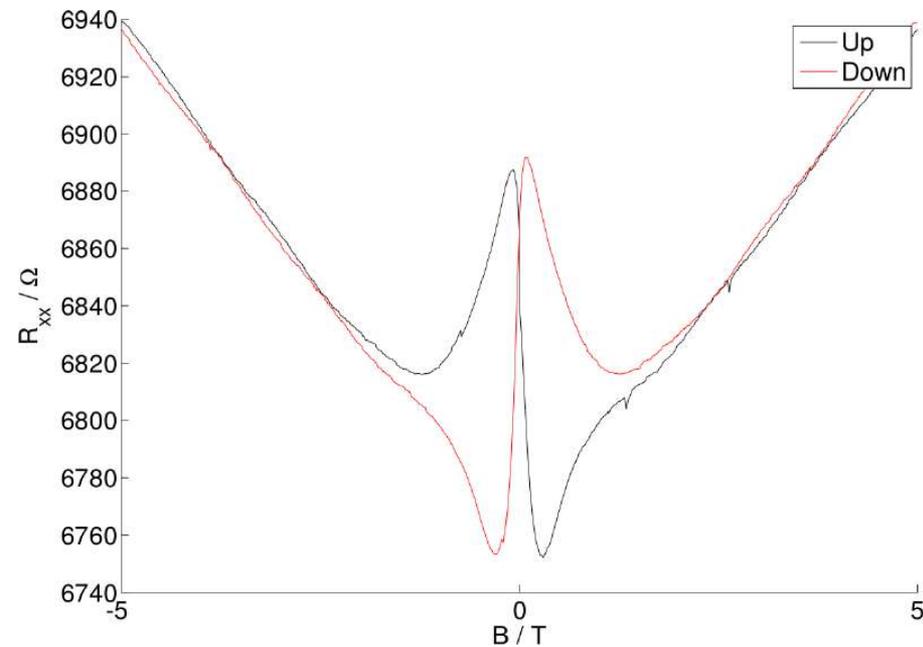
Resistance low with large $\frac{dE}{dk}$



Resistance low with large $\frac{dk}{dE}$



Summary



GeAu displays hysteresis

Depends on B and dB/dt

Antisymmetric around $B=0$

Could be driven by
precession in spin-orbit field