Long-range superconducting proximity effect



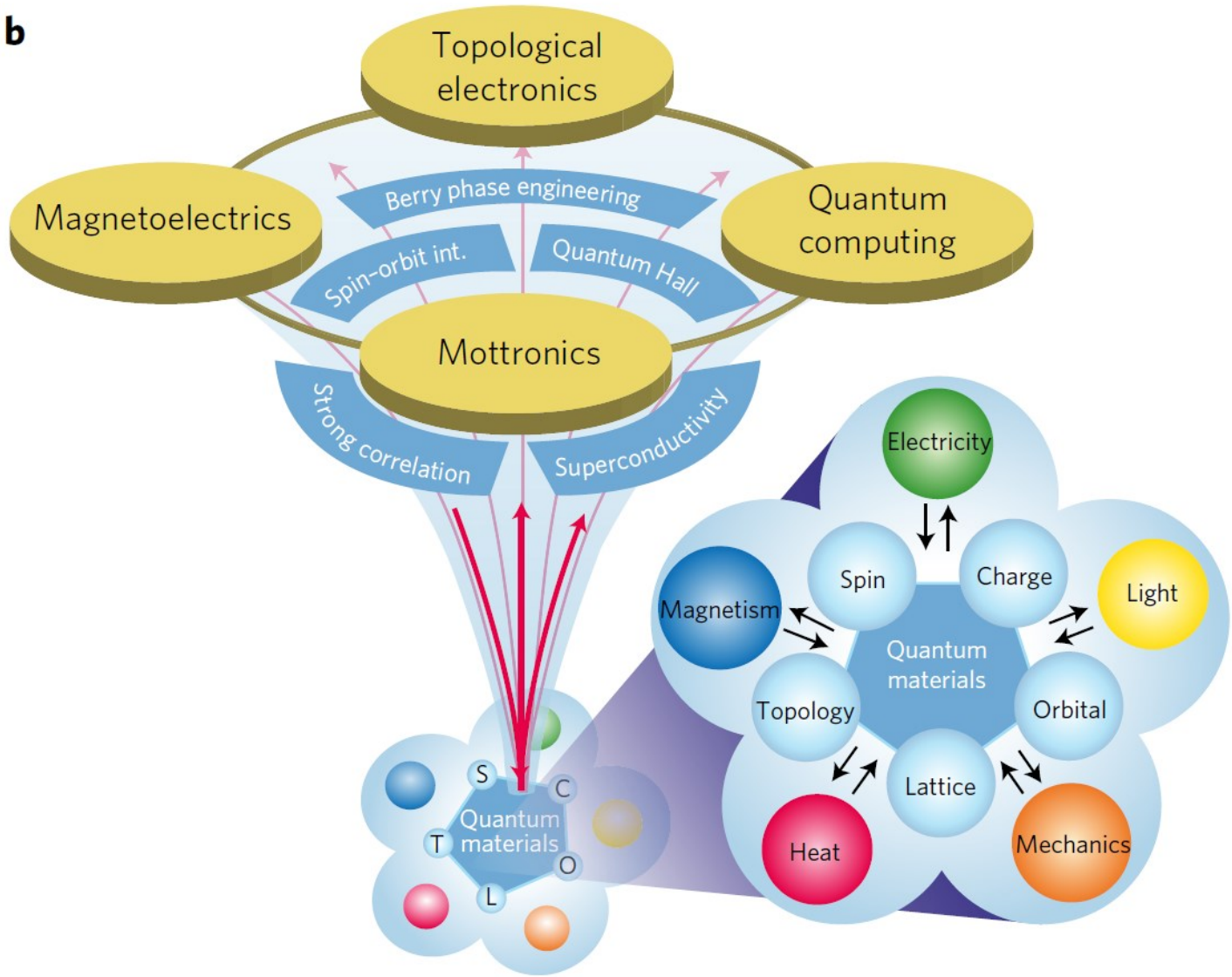
Jacobo Santamaría
U. Complutense de Madrid

www.ucm.es/info/gfmc

Universidad Complutense Madrid

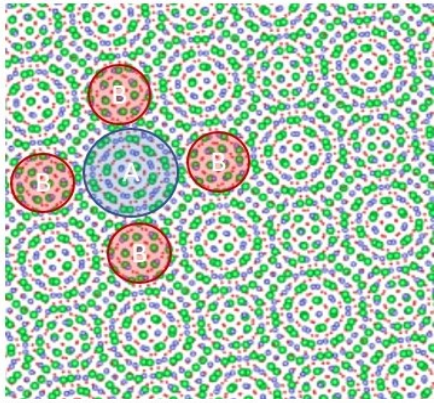


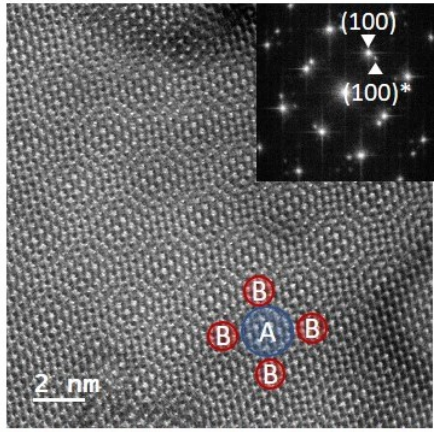
GFMC



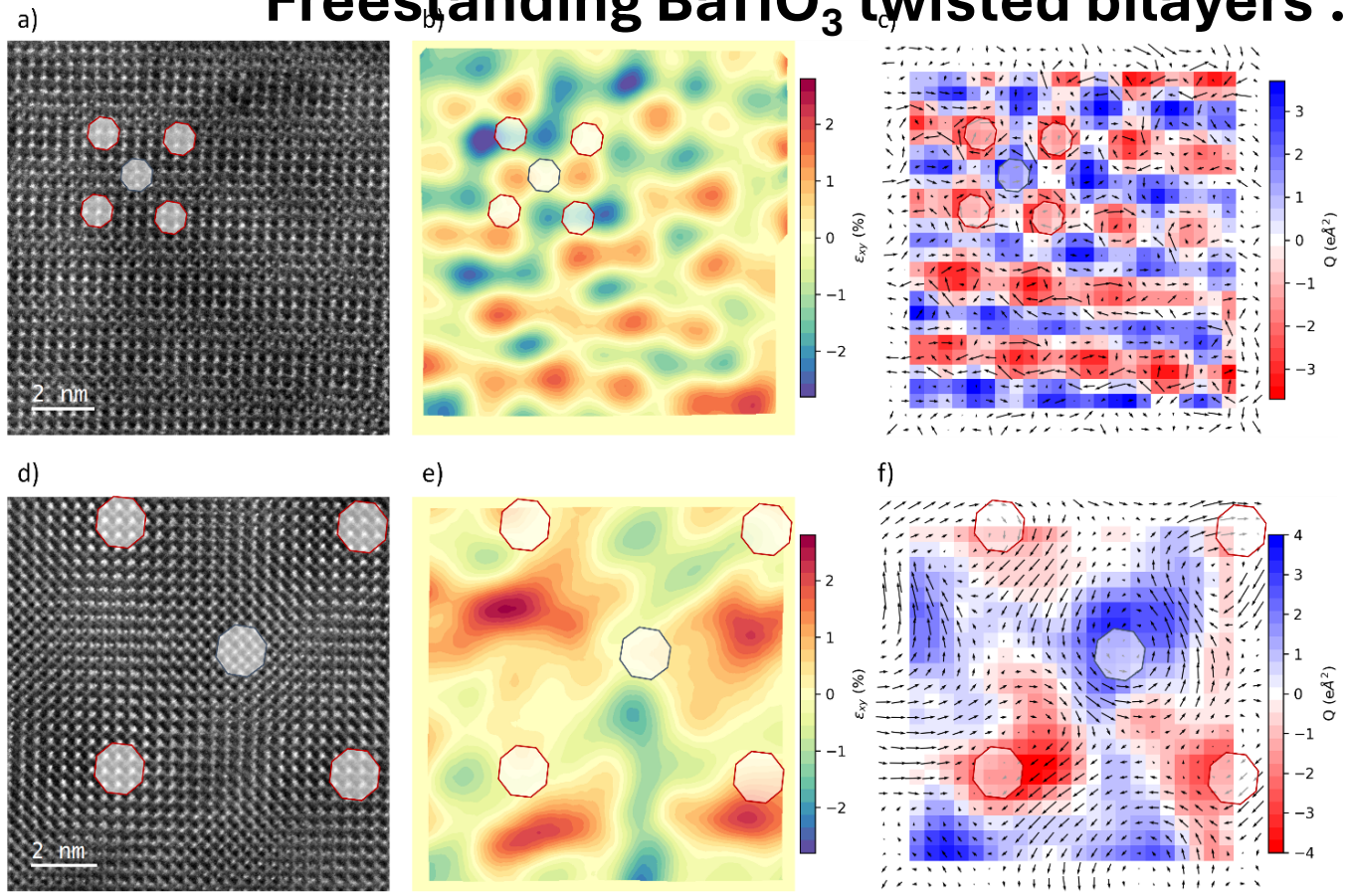
adapted from Y. Tokura. Nature Physics 13 (2017)

We have shown...ferroelectric twistronics





Freestanding $BaTiO_3$ twisted bilayers .



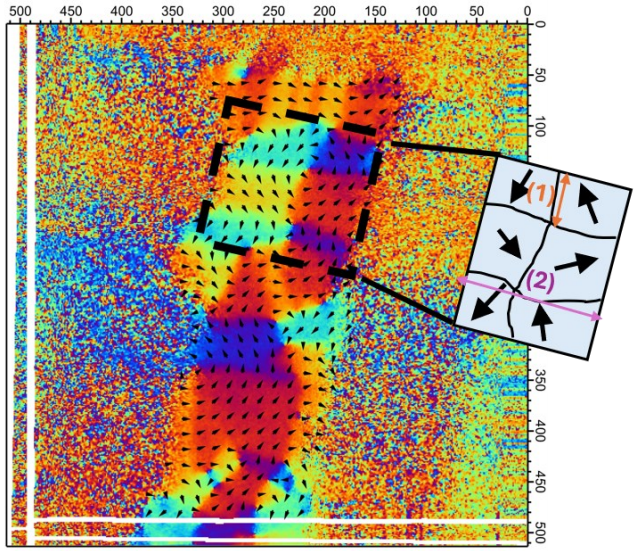
We have shown an array of ferroelectric vortices driven by moiré inhomogeneous strains

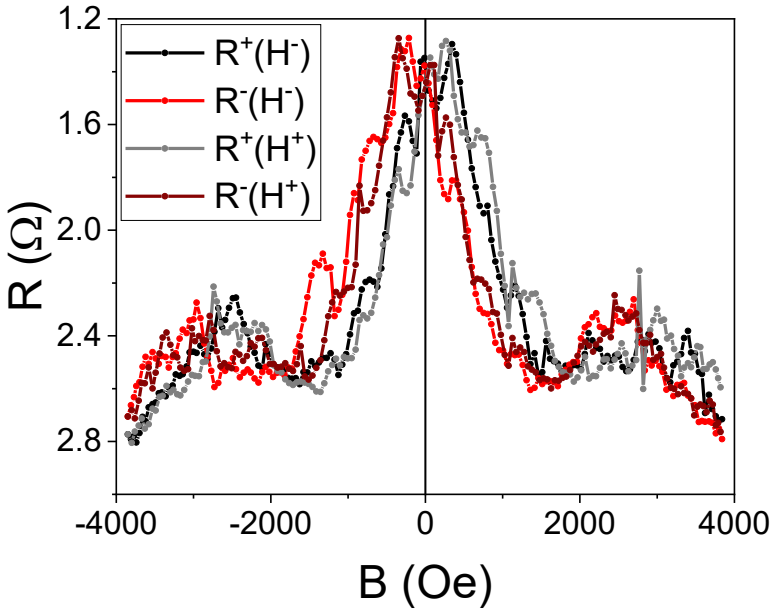
Nature **626,** 529 (2024)

Advanced Materials (2026): adma e12969.

Focus point 1.....

ANOMALOUS Josephson effect in $La_{0.7}Sr_{0.3}MnO_3$ / $YBa_2Cu_3O_7$ JJ driven by non coplanar spin textures of a ferromagnetic weak link

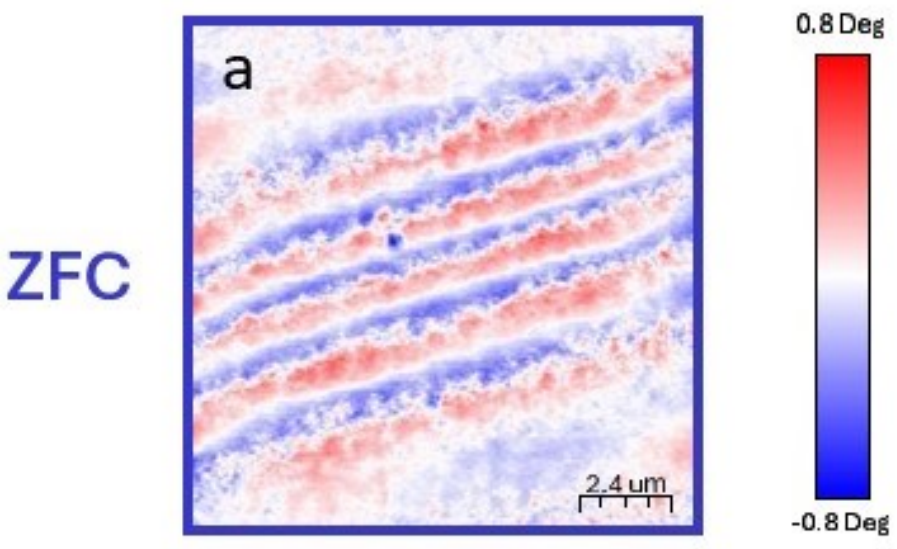


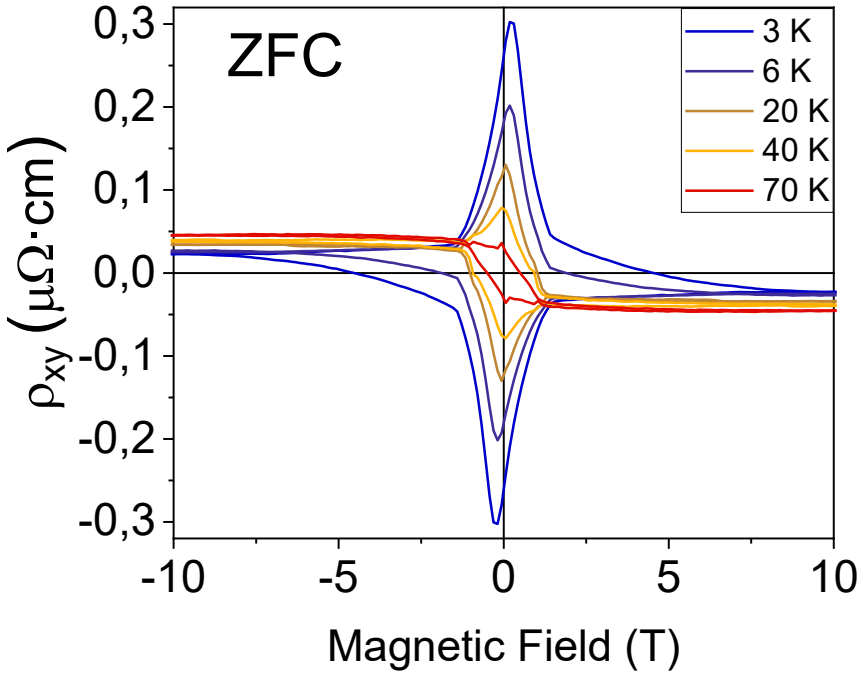


Ph D Sara Rodriguez Corvillo unpublished

Focus point 2…..

LARGE TUNABLE THE in $La_{0.7}Sr_{0.3}MnO_3$ / $SrIrO_3$ oxide interfaces driven by spin chirality induced by the interplay between correlations and topology





A. Peralta Comms. Mater (2026)

European Innovation Council

Josephine

ANOMALOUS JOSEPHSON EFFECT IN YBCO/LSMO/YBCO JUNCTIONS

Sara Rodríguez Corvillo[1], **Andrei Mazanik**[2], Evangelos Golias[3], Sergio Valencia[4], Alejandro Martín Merodio[1], Salvatore Mesoraca[5], Mariam Martirosyan[1], Víctor Rouco[1], Fabián Andrés Cuéllar[1], **Sebastián Bergeret**[2], Carlos León[1], David Sánchez Manzano[1], **Javier E. Villegas**[5], Jacobo Santamaría[1]

[1] *GFMC, Departamento de Física de Materiales, Universidad Complutense de Madrid, Madrid, Spain*
[2] *Centro de Física de Materiales (CFM-MPC), Centro Mixto CSIC-UPV/EHU, San Sebastián, Spain*
[3] *Max IV Laboratory, Lund, Sweden*
[4] *Helmholtz-Zentrum Berlin, BESSY II, Berlín, Germany*
[5] *Laboratoire Albert Fert, CNRS, THALES, Université Paris-Saclay, Palaiseau, France*

Donostia International Physics Center

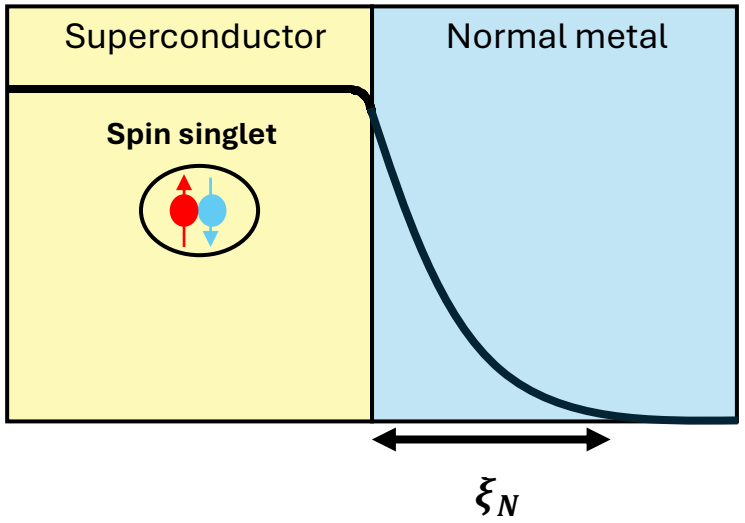
HZB Helmholtz Zentrum Berlin

laboratoire Albert Fert

GFMC

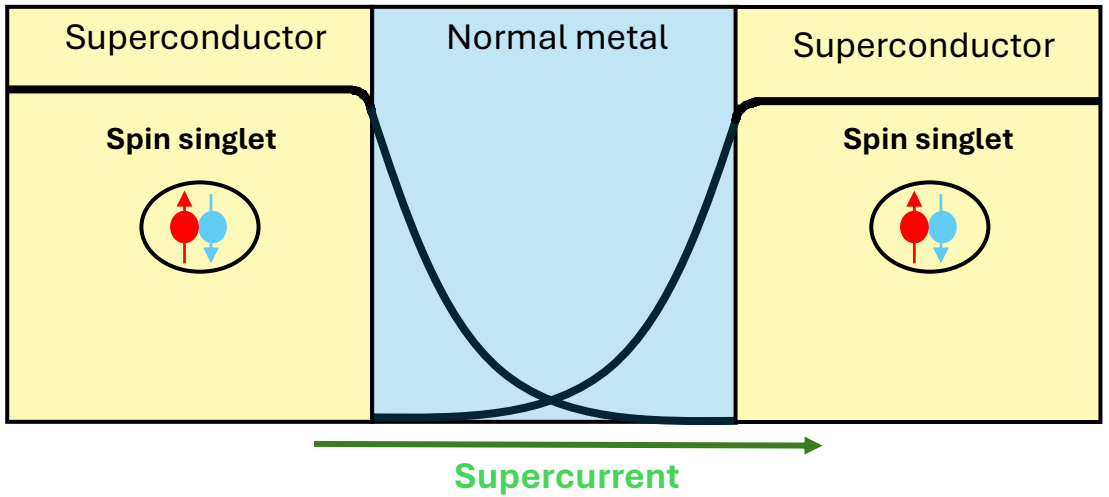
UNIVERSIDAD COMPLUTENSE MADRID

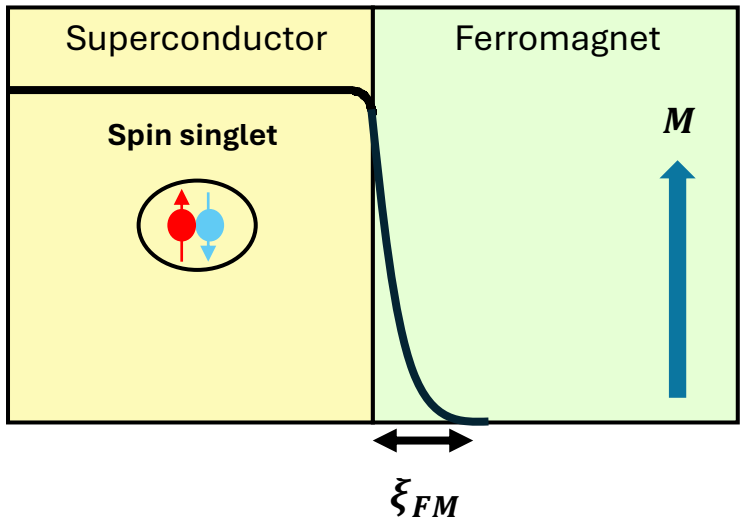
Superconducting proximity effect



$$\xi_N = \sqrt{\frac{\hbar D}{2\pi k_B T}}$$

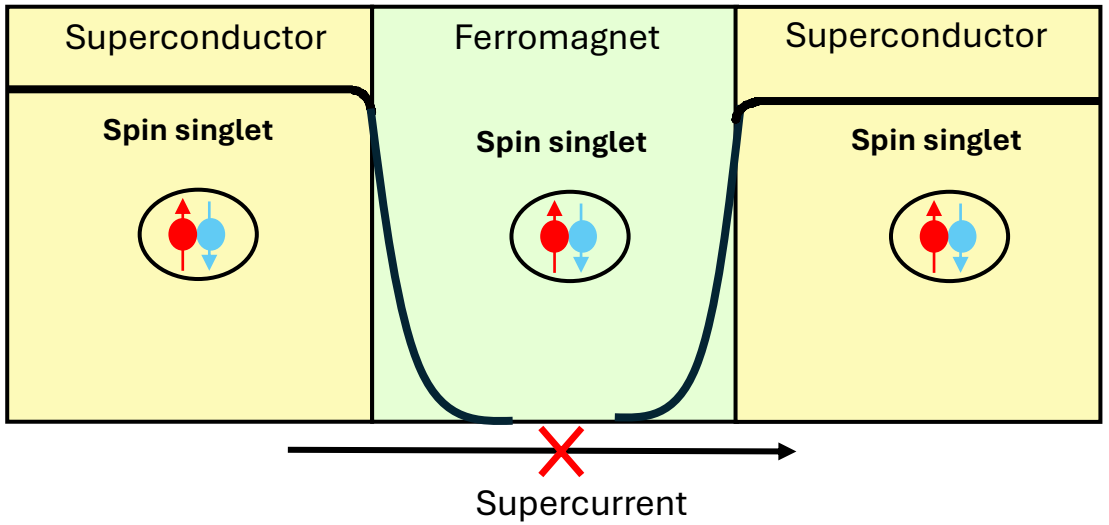
$$\xi_N \approx 100\ nm\ - 1\ \mu m$$





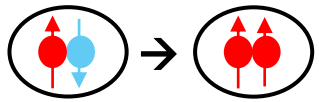
$$\xi_{FM} = \sqrt{\frac{\hbar D}{E_{ex}}}$$

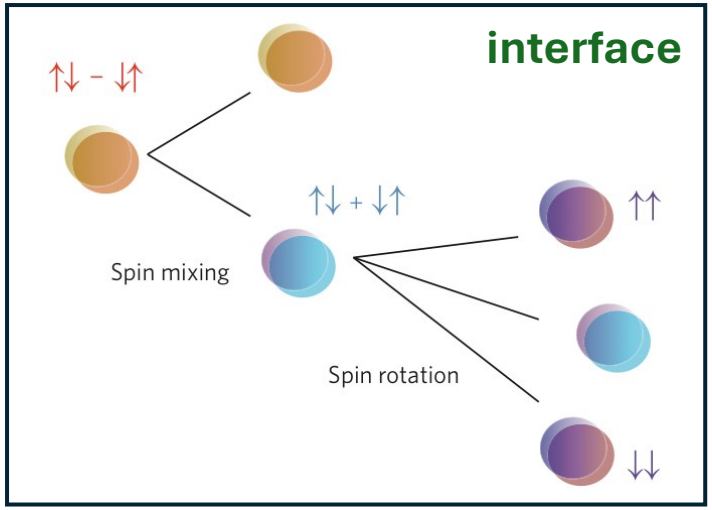
$$\xi_{FM} < 10nm$$

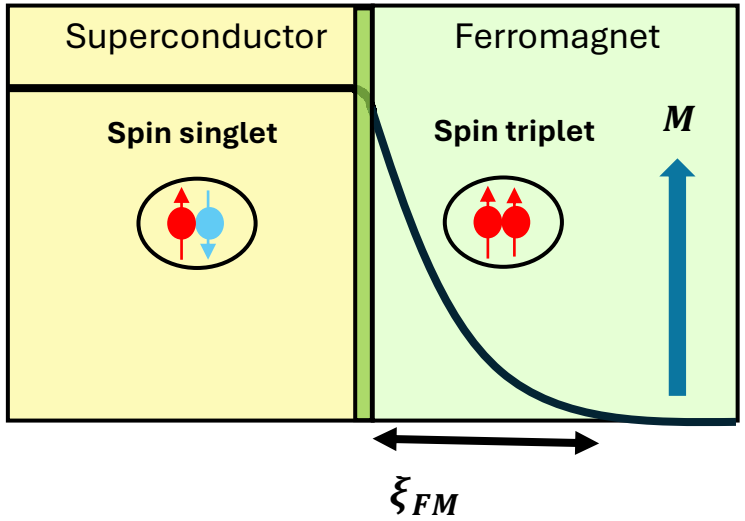


Triplet superconducting proximity effect

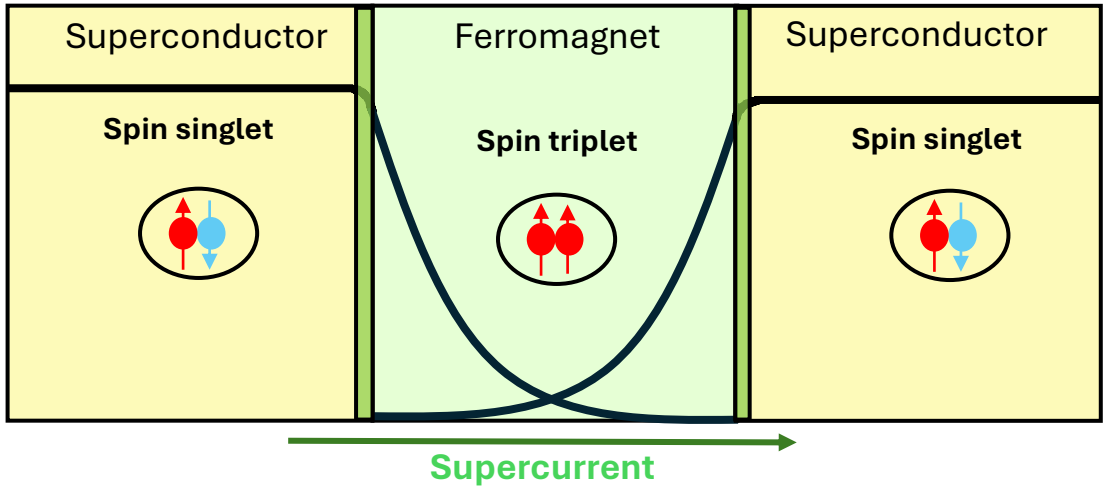
Spin Singlet to Triplet conversion







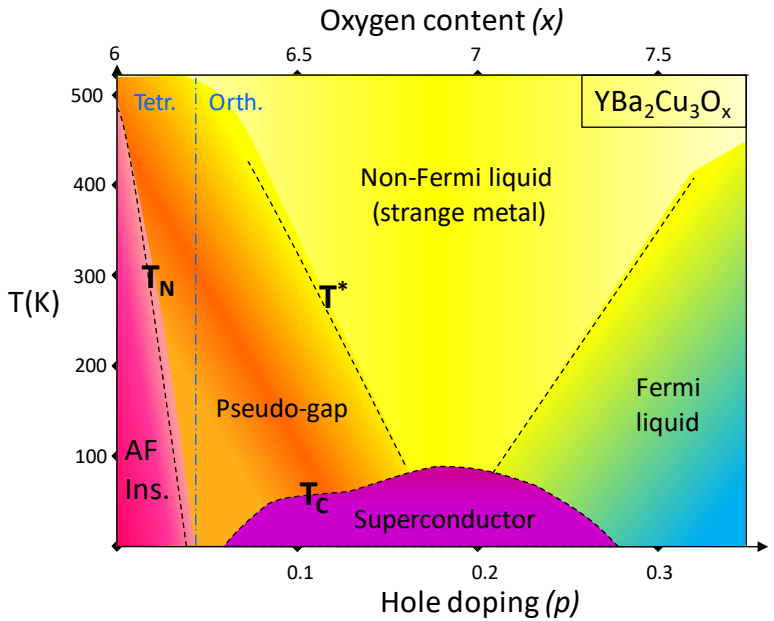
$\xi_{FM} \approx 1\ \mu m$



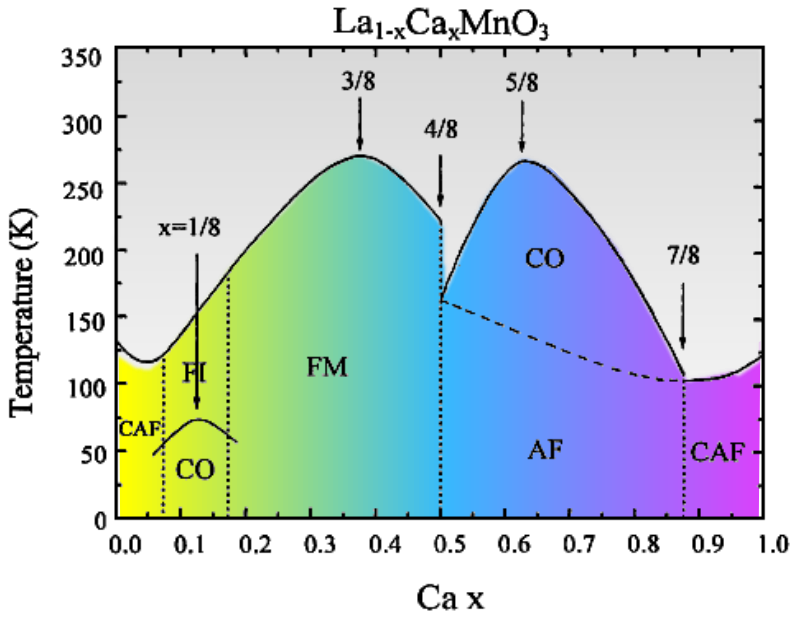
Spin polarized supercurrent → Superconducting Spintronics

$YBa_2Cu_3O_7$ / $La_{0.7}Sr_{0.3}MnO_3$

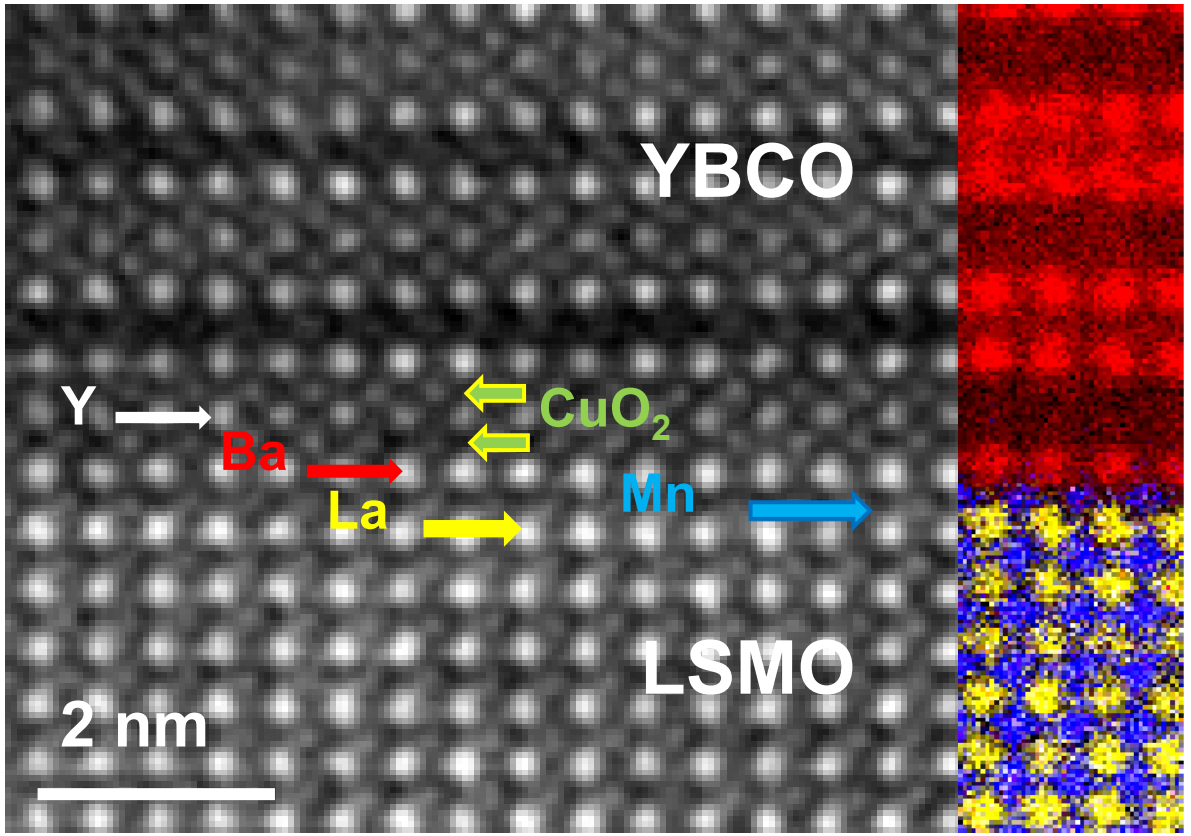
SC d-wave



FM half metal



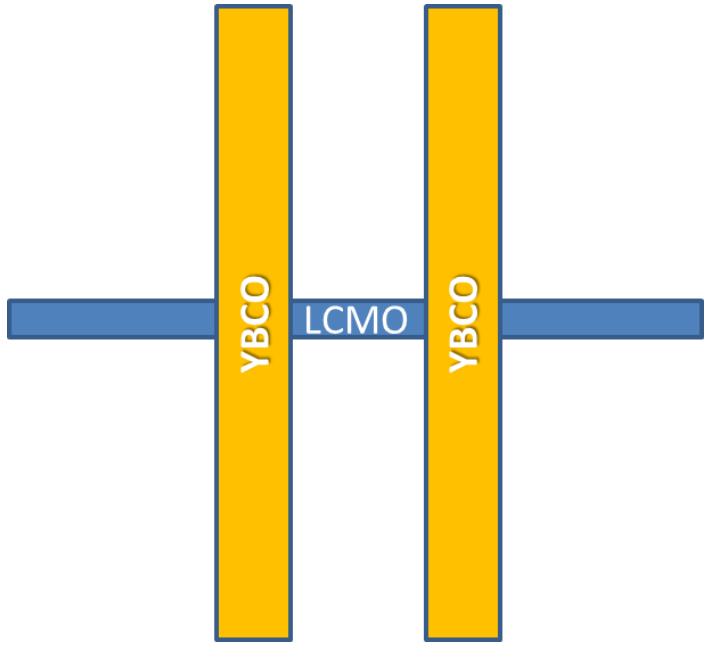
$YBa_2Cu_3O_7$ / $La_{0.7}Sr_{0.3}MnO_3$ INTERFACES



D. Sanchez-Manzano Nat Mater **21**, 188 (2022)

microwires

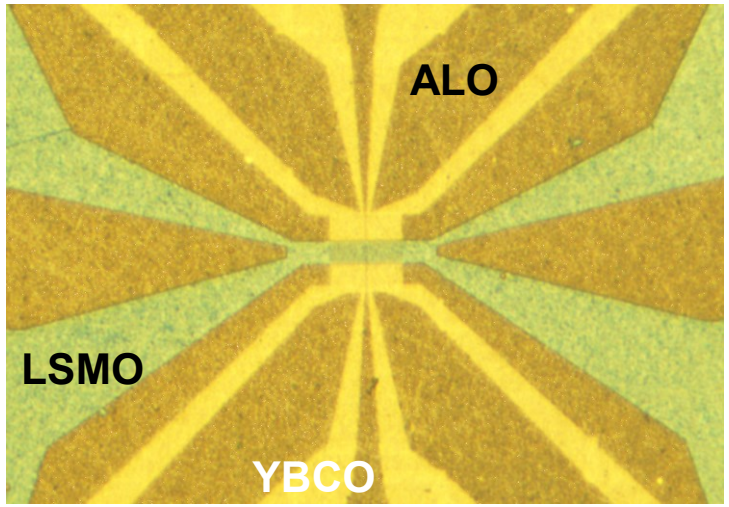
YBCO/LSMO

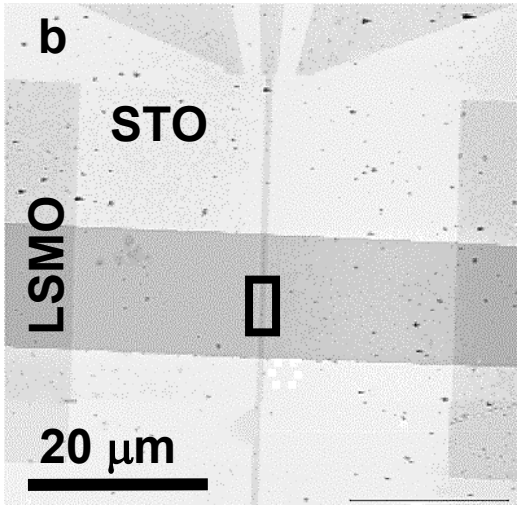


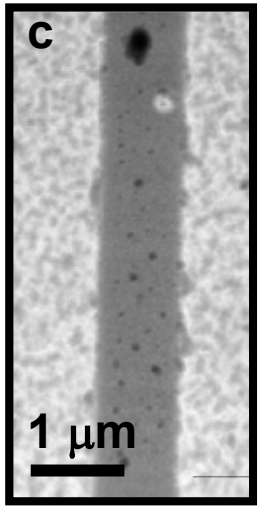
- **Well defined current geometry and magnetic state**

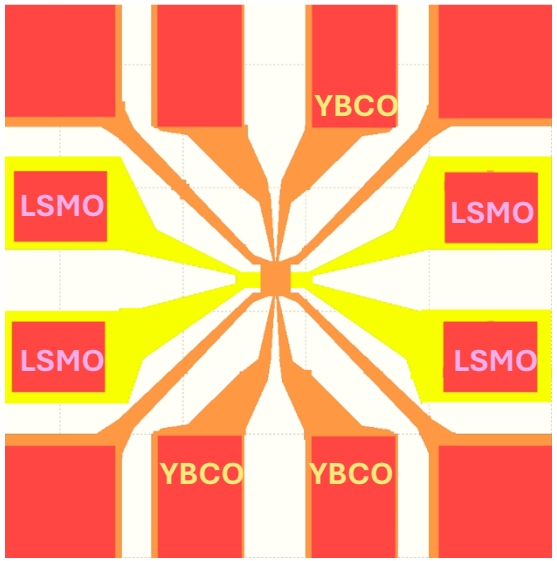
D. Sanchez-Manzano Nat Mater **21**, 188 (2022)

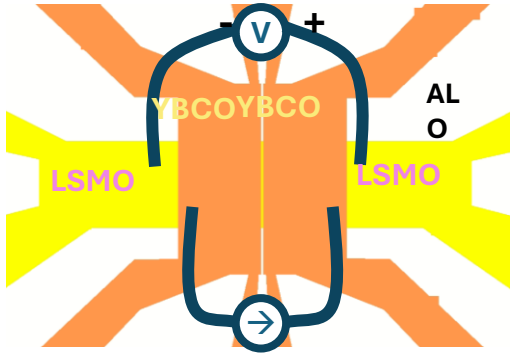
DEVICE FABRICATION (III). Actual device's structure

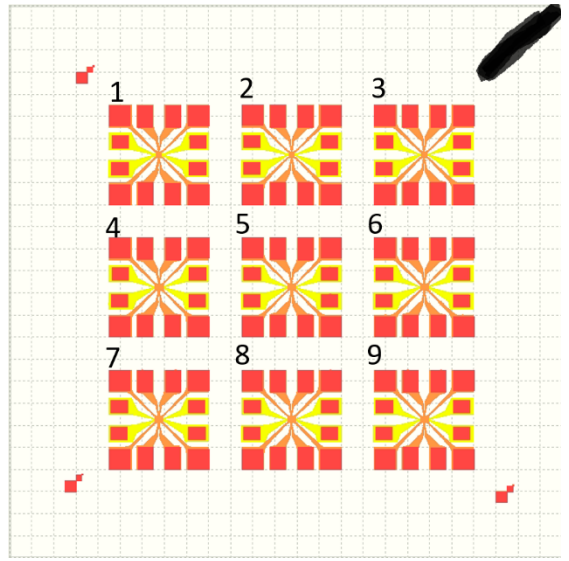




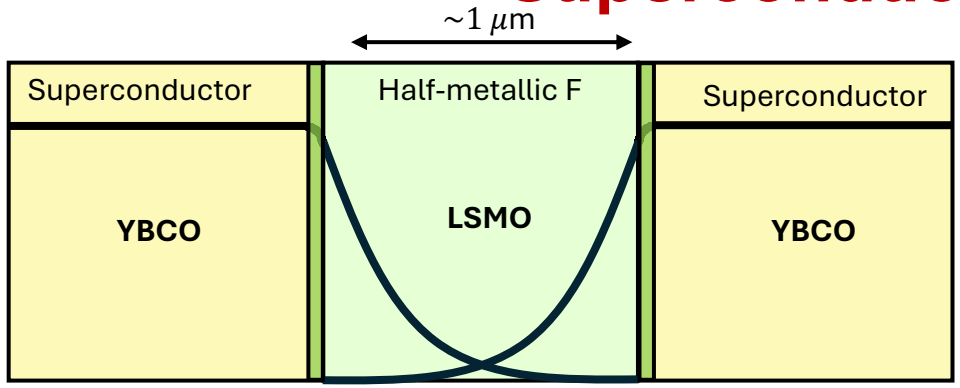






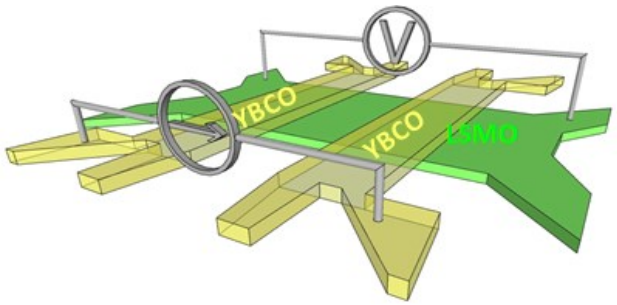


Superconducting proximity effect

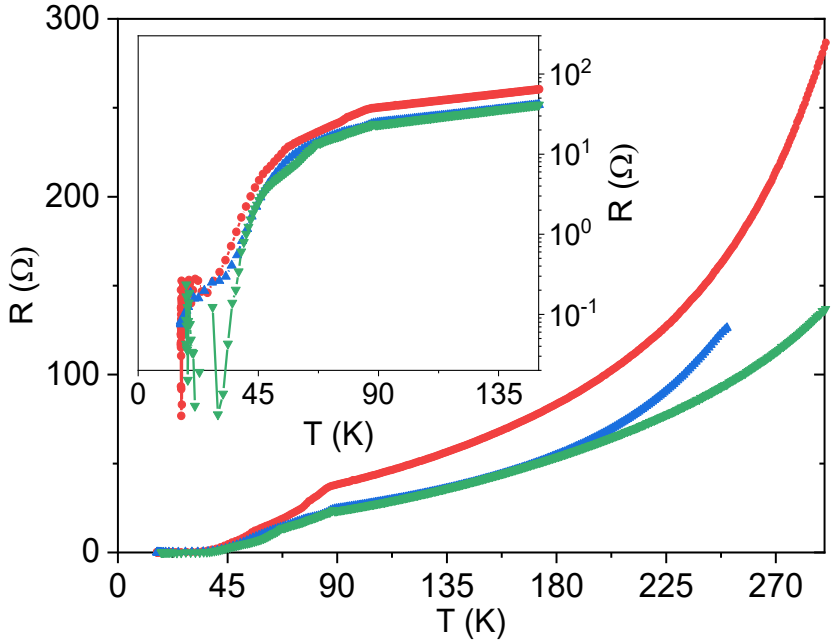


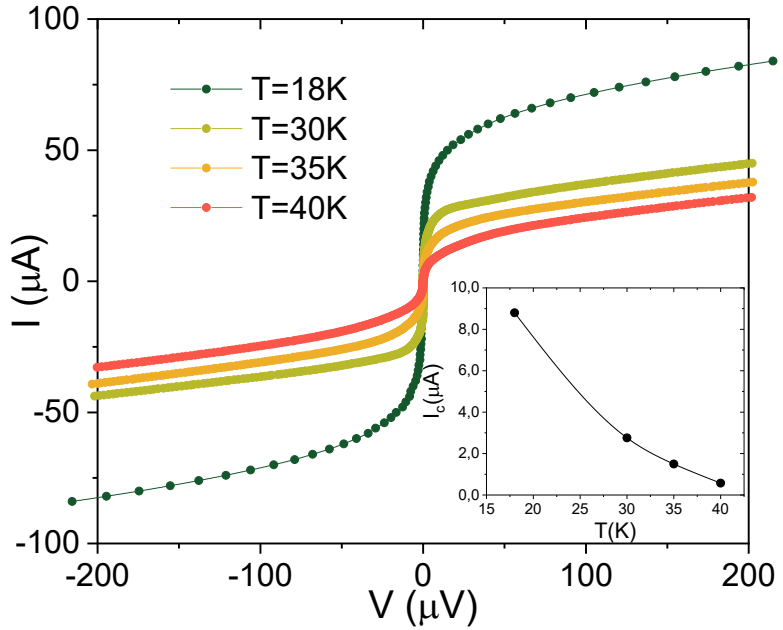
$YBa_2Cu_3O_7$ (YBCO)
- High Tc unconventional SC
- Spin-singlet d-wave
- T_c=91 K

$La_{0,7}Sr_{0,3}MnO_3$ (LSMO)
- Half-metallic ferromagnet
- Full spin polarization at the Fermi level



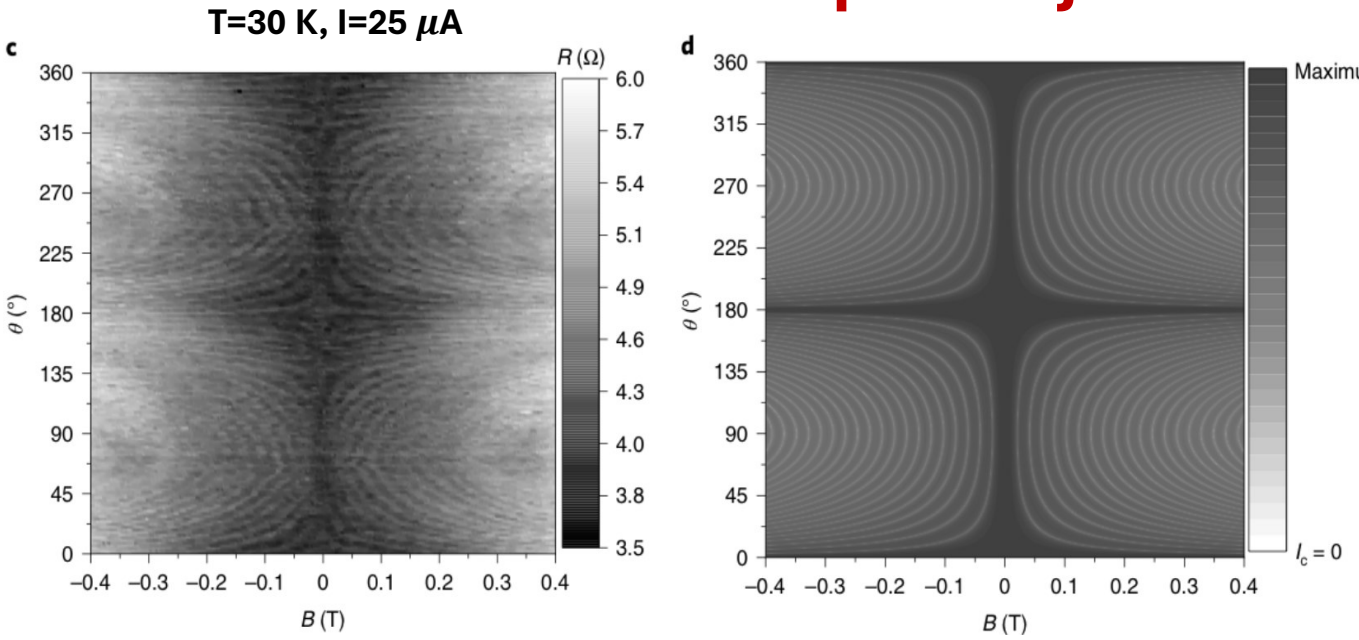
D. Sanchez-Manzano, *et al.* ***Nature Materials* 21**, 188–194 (2022)



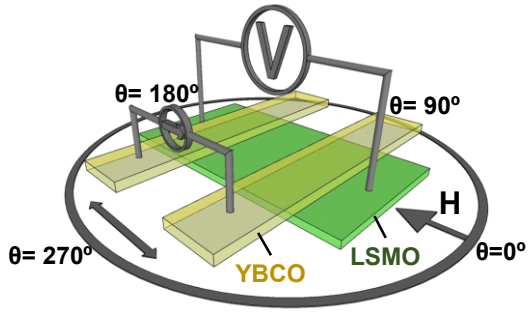


Supercurrent through the junction driven by equal spin-triplet pairs

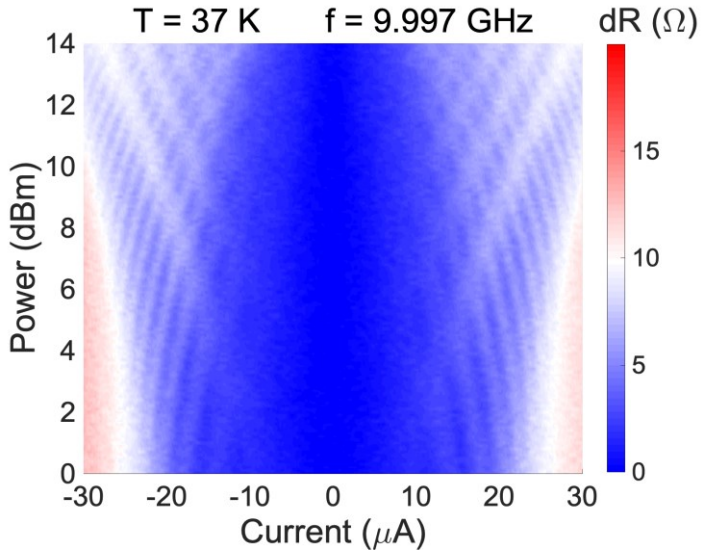
Josephson junction features

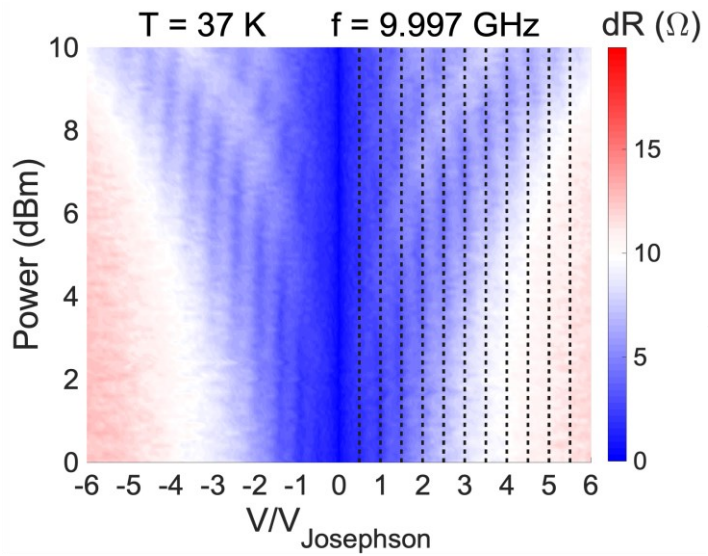


In-plane magnetic field!!



$$I_c = I_0 \left| \frac{\sin\left(\frac{\pi\phi}{\phi_0}\right)}{\left(\frac{\pi\phi}{\phi_0}\right)} \right| = I_0 \left| \frac{\sin\left(\frac{\pi H_\perp wL}{\phi_0}\right)}{\left(\frac{\pi H_\perp wL}{\phi_0}\right)} \right| = I_0 \left| \frac{\sin\left(\frac{\pi H \sin\theta\, wL}{\phi_0}\right)}{\left(\frac{\pi H \sin\theta\, wL}{\phi_0}\right)} \right|$$





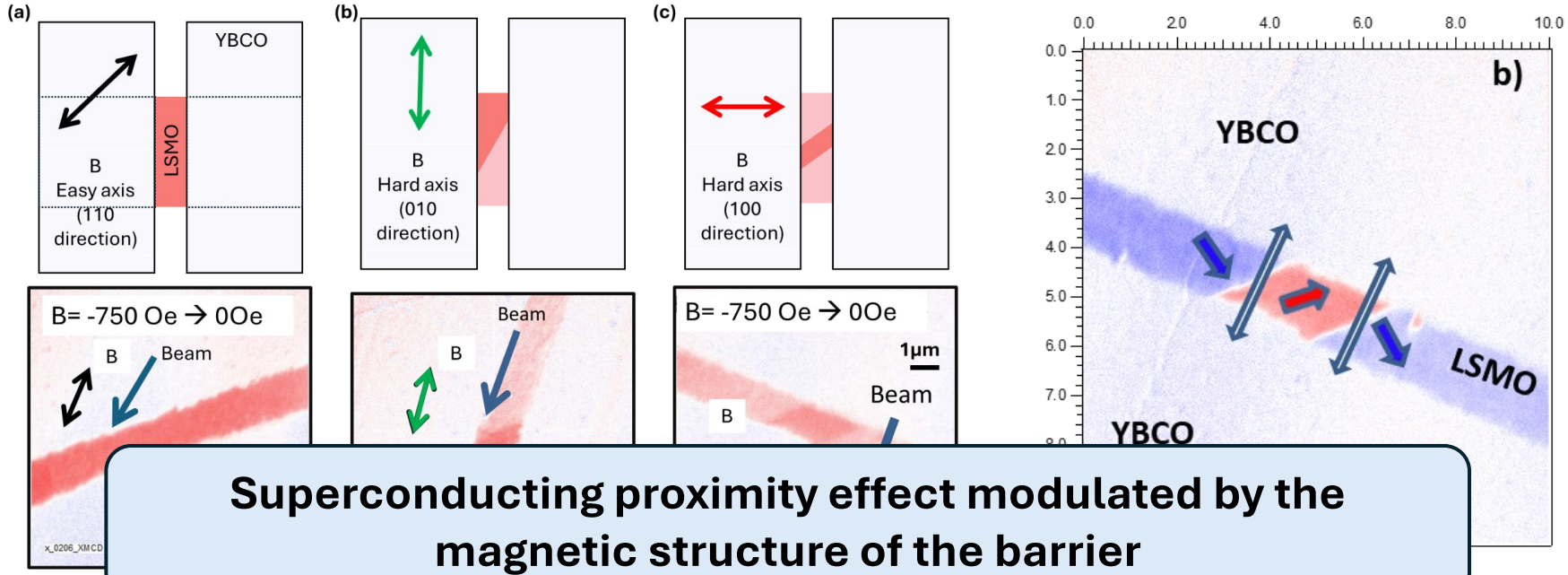
Half integer Saphiro steps → **Second harmonic component in CPR**

Second harmonic: $L_{eff} = 2 \times (L_{junction} + 2\lambda_{YBCO})$

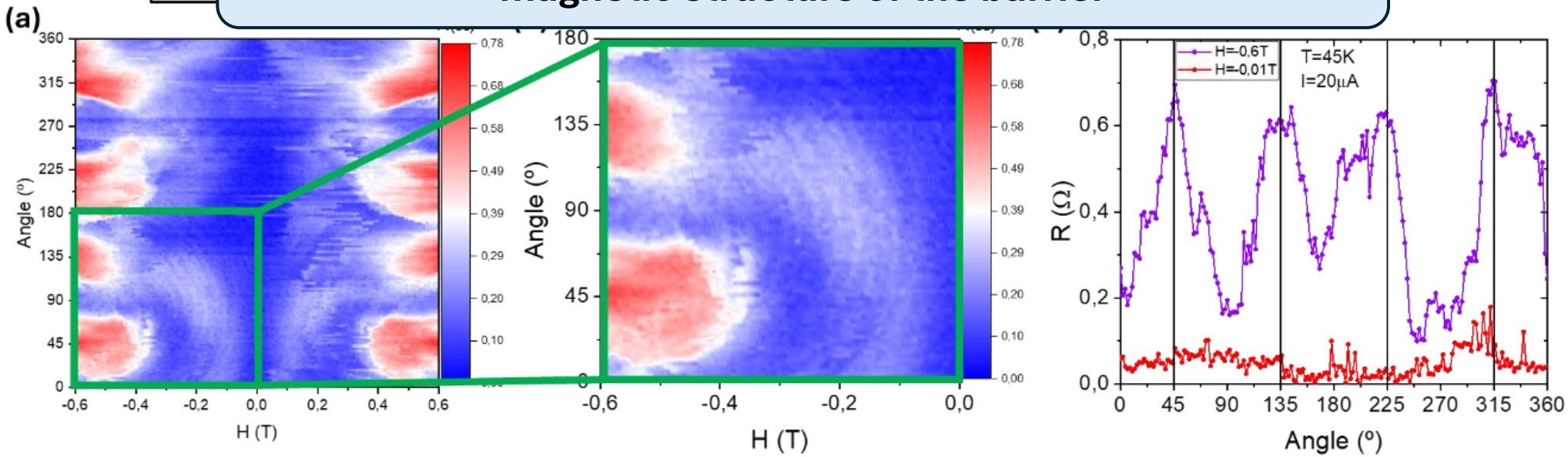
D. Sanchez-Manzano, *et al. Nature Materials* 21, 188–194 (2022)

HZB Helmholtz Zentrum Berlin

XMCD-PEEM study: in-plane fields



Superconducting proximity effect modulated by the magnetic structure of the barrier

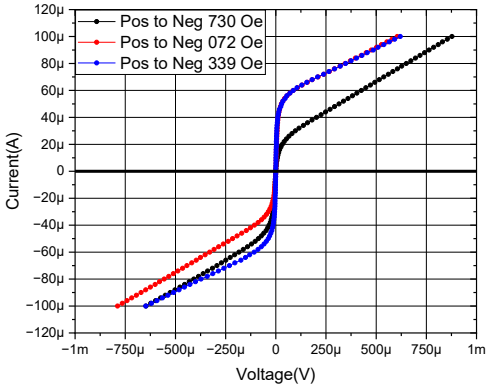


In collaboration with Dr. Sergio Valencia (BESSY II)

CFI symmetry: TRS

$$I(\varphi) = I_c \sin(\varphi)$$

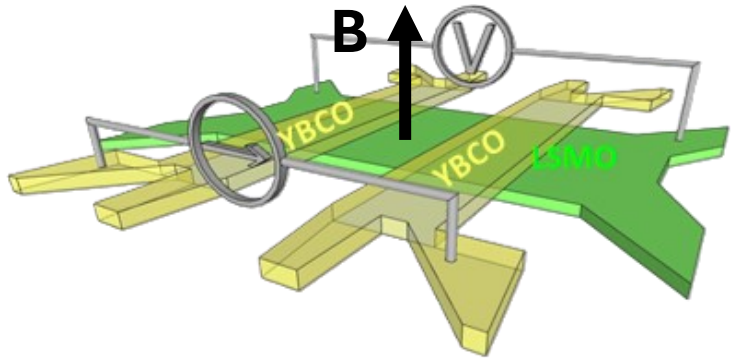
CFI asymmetry: broken TRS

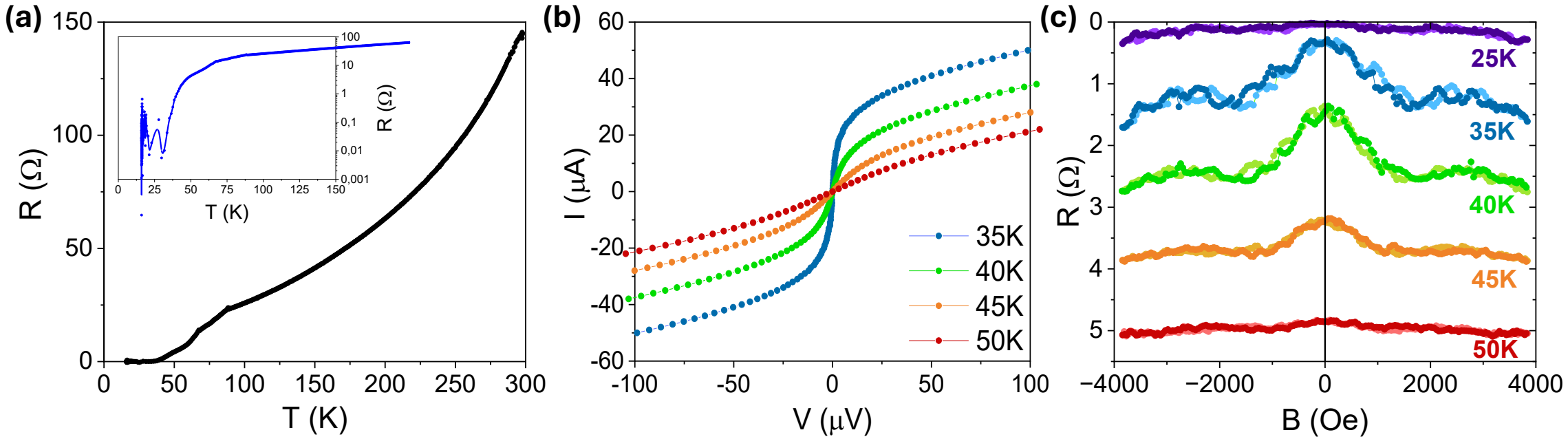


$$\boldsymbol{I(\varphi) = I_c \sin(\varphi + \varphi_0)}$$

Spin orbit A. Buzdin, Phys. Rev. Lett. 101, 107005 2008
Unconventional SC M. Sigrist, Prog. Theor. Phys. 99, 899 1998.
S. Kashiwaya and Y. Tanaka, Rep. Prog. Phys. 63, 1641 2000
Non coplanar spin text. J.-F. Liu and K. S. Chan, Phys. Rev. B 82, 125305 (2010).
Iryna Kulagina and Jacob Linder, Phys Rev B. 90,054504 (2014)

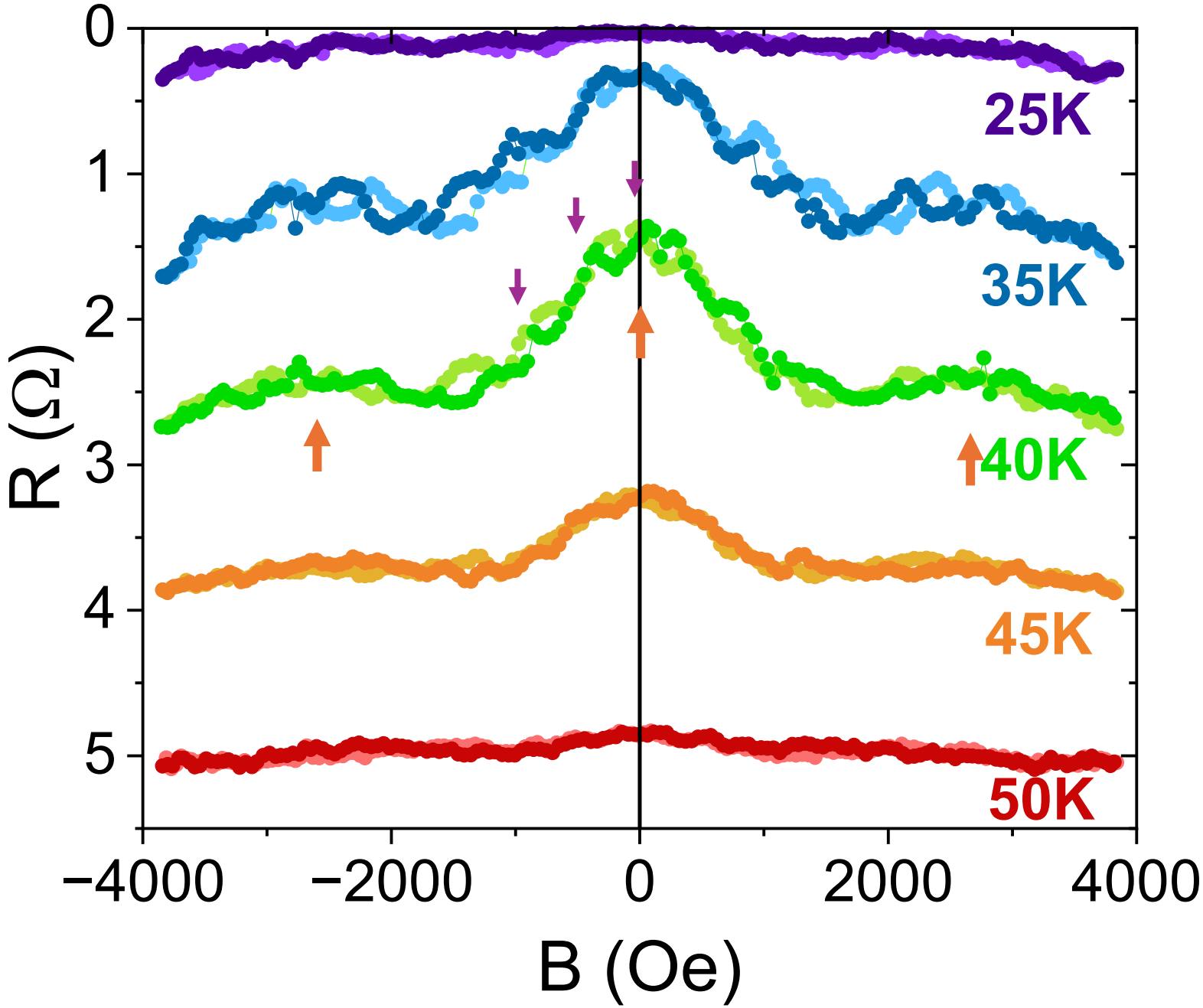
Transport characterisation of the junction





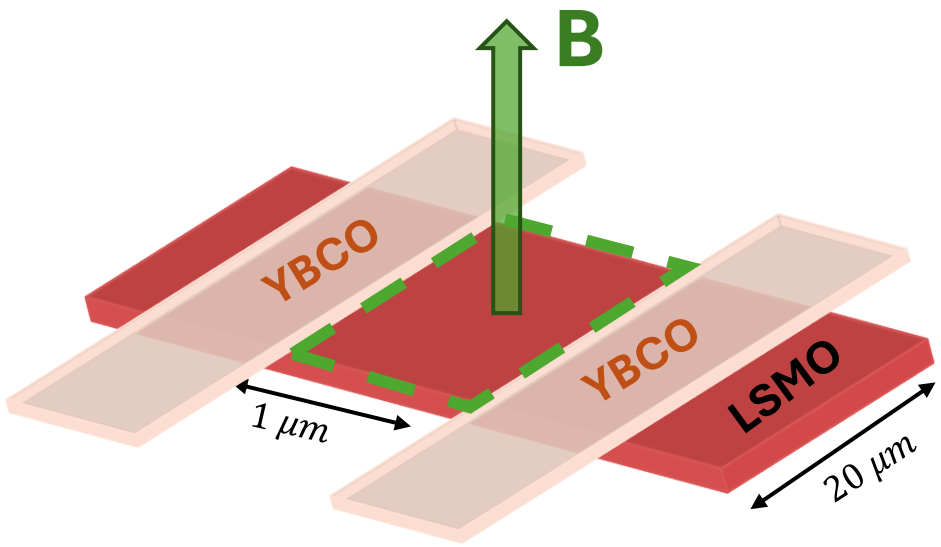
Resistance is modulated by an **out-of-plane** magnetic field

B=30 mT →
A_{eff}= 0.070 μm^2



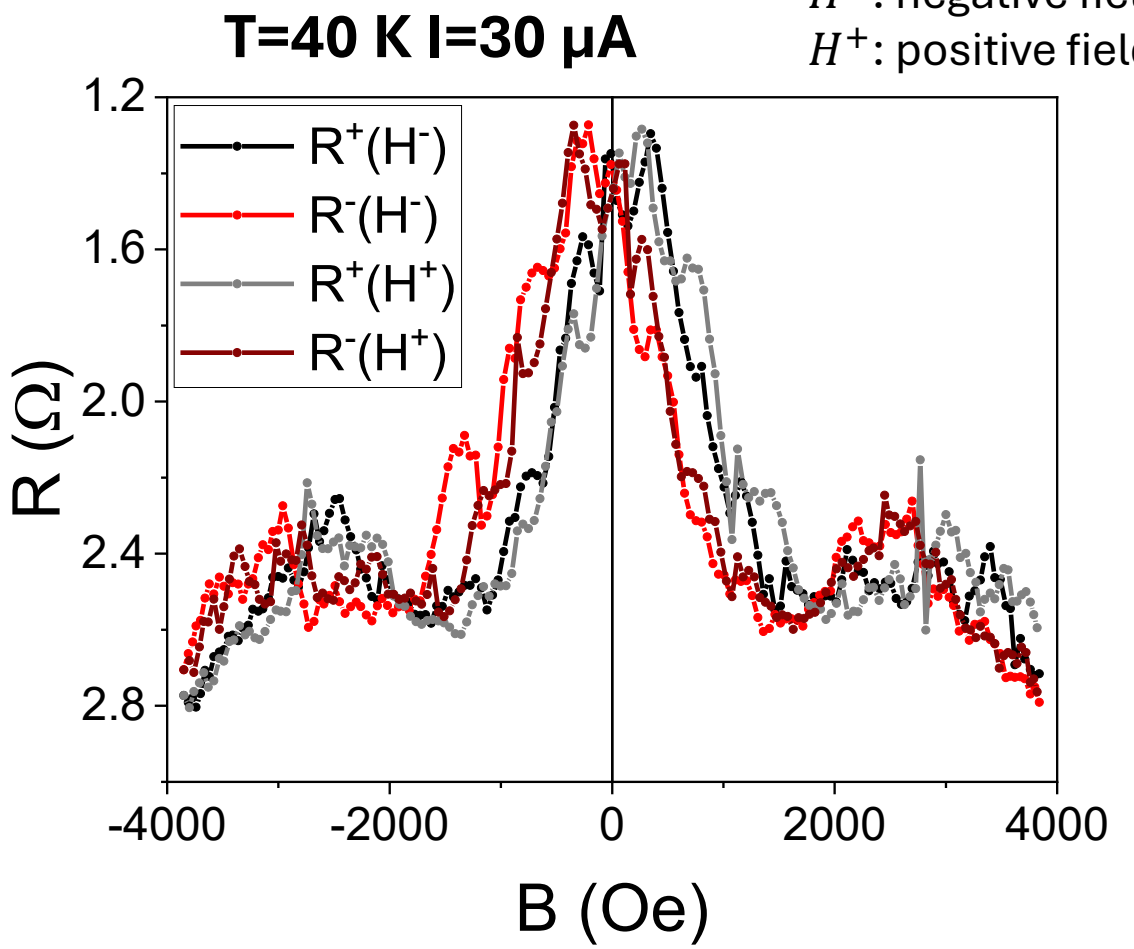
B=140 mT →
A_{eff}= 0.015 μm^2

Transport characterisation of the junction



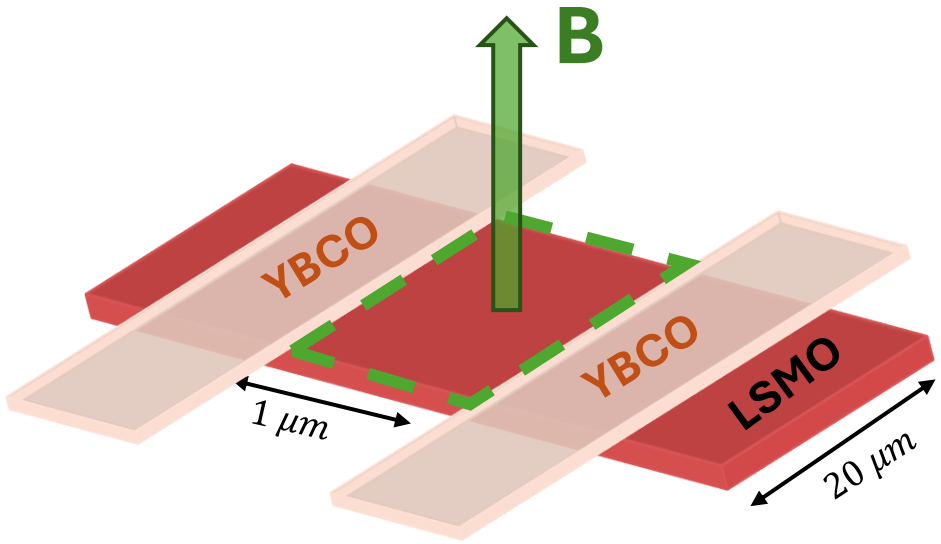
A_{eff}= 1x20 μm^2 → B ~ 1 Gauss

H^-: negative field sweep
H^+: positive field sweep



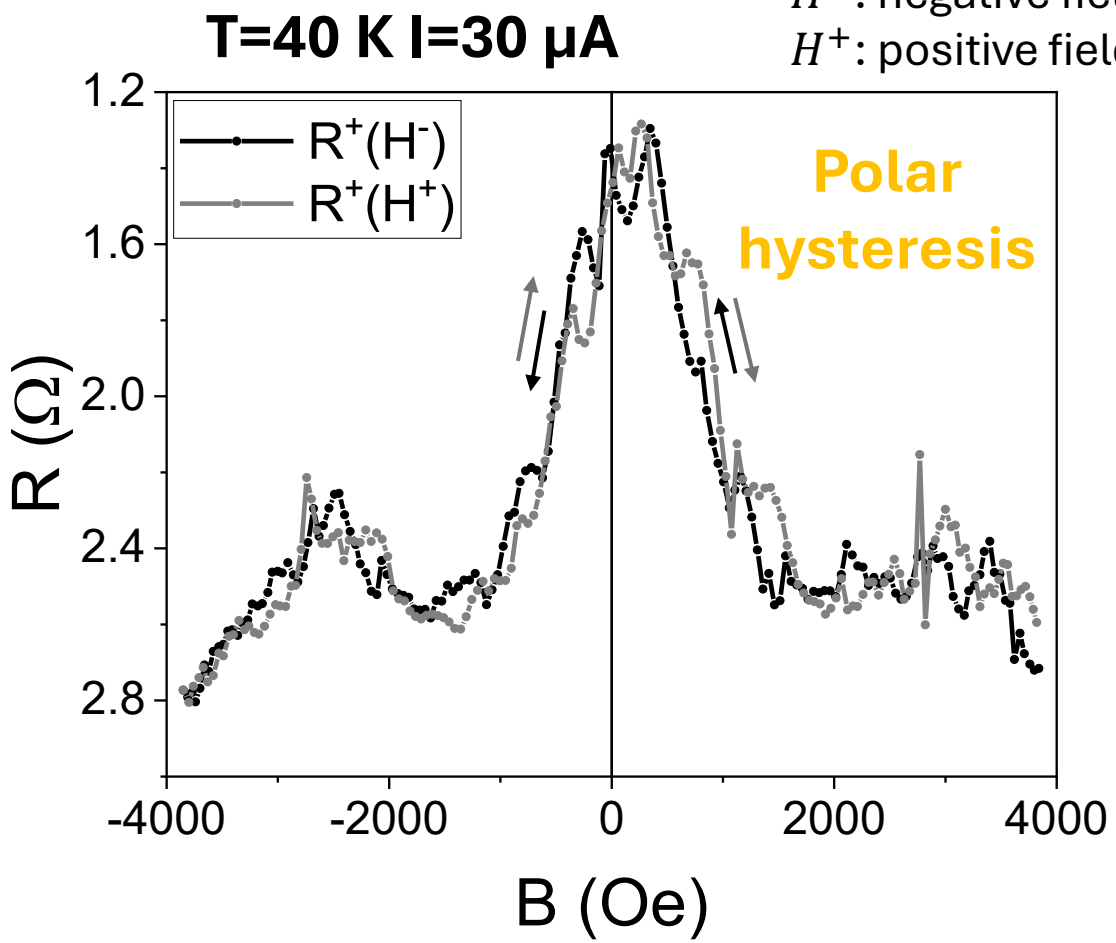
Anomalous features in the Fraunhofer pattern when the magnetic field is **out of the plane**

Transport characterisation of the junction



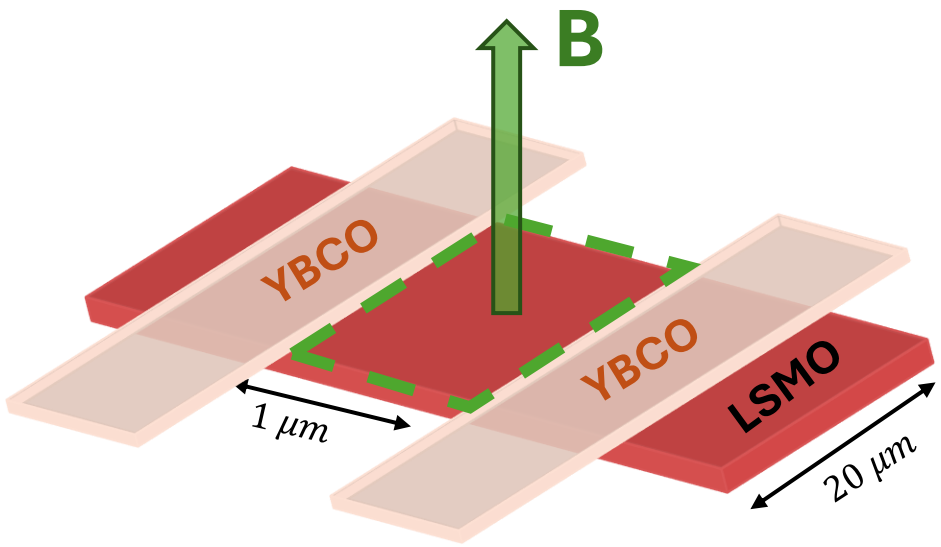
A_{eff}= 1x20 μm^2 → B ~ 1 Gauss

H^-: negative field sweep
H^+: positive field sweep



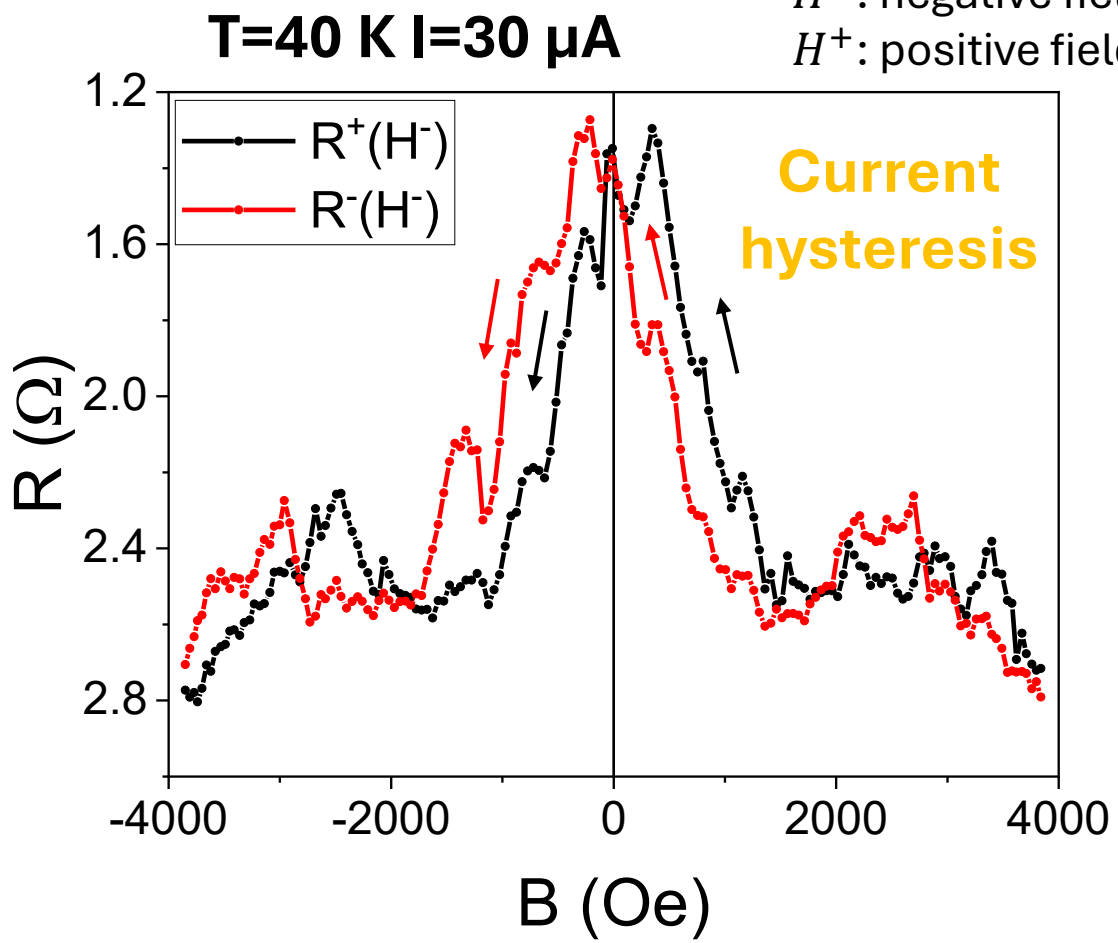
Anomalous features in the Fraunhofer pattern when the magnetic field is **out of the plane**

Transport characterisation of the junction



A_{eff}= 1x20 μm^2 → B ~ 1 Gauss

H^-: negative field sweep
H^+: positive field sweep



Anomalous features in the Fraunhofer pattern when the magnetic field is **out of the plane**

→We have found experimental evidence of Josephson coupling **across magnetic domain walls** in planar YBCO/LSMO/YBCO junctions.

→The **anomalous Fraunhofer asymmetry** demonstrates that spatial inversion and time-reversal symmetries are simultaneously broken by the net spin chirality embedded in the magnetic barrier.

→These results provide direct evidence for an intrinsic φ_0-Josephson state.

GIANT TUNABLE TOPOLOGICAL HALL EFFECT IN $La_{0.7}Sr_{0.3}MnO_3$ / $SrIrO_3$ BILAYERS

Andrea Peralta-Somoza[1], Rafael Fuster[1], Sandra Lopez[1], Fernando Gallego[1], Sergio Valencia[2], Juan J. Riquelme[3,4], Mariona Cabero[5], Javier Tornos [1], Carmen Munuera[3,4], Federico Mompeán[3,4], Mar García-Hernández[3,4], Timothy R. Charlton[6], Brian J. Kirby[7], Stephan Rosenkranz[8], Zouhair Sefrioui[1], Javier E. Villegas[9], Suzanne G.E. te Velthuis[8], Carlos León[1,4] and Jacobo Santamaría [1,4, #]

[1] *GFMC, Dept. Fisica de Materiales, Facultad de Fisica, U. Complutense, 28040 Madrid, Spain*
[2] *Helmholtz Zentrum Berlin für Materialien und Energie, 12489 Berlin, Germany*
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[7] *NIST Center for Neutron Research, National Institute of Standards and Technology, Gaithersburg, Maryland, 20899, USA*
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•J. E. Villegas

•J. Riquelme, C. Munuera, F. Mompean, C. Muñoz, M. Garcia Hernandez (ICMM- CSIC)

G. Sanchez-Santolino, (UCM) N. Shibata, Y. Ikuhara

S. Valencia, *Helmholtz-Zentrum Berlin für Materialen und Energie*

T. Charlton

B. Kirby

Iridates

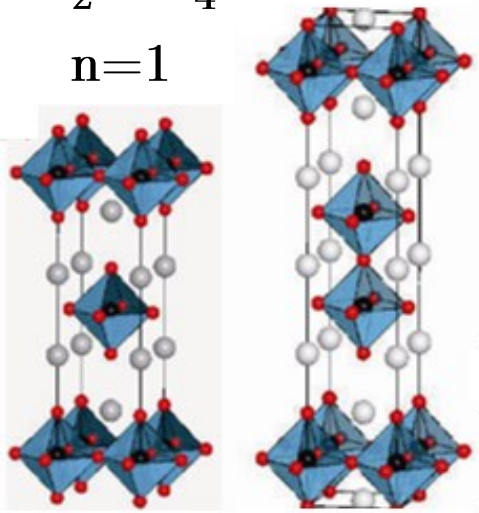
Ruddlesen-Popper serie	$Sr_{n+1}Ir_nO_{3n+1}$ (n=1, 2… ∞)

$Sr_3Ir_2O_7$

n=2

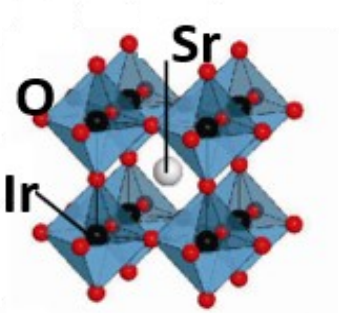
Sr_2IrO_4

n=1

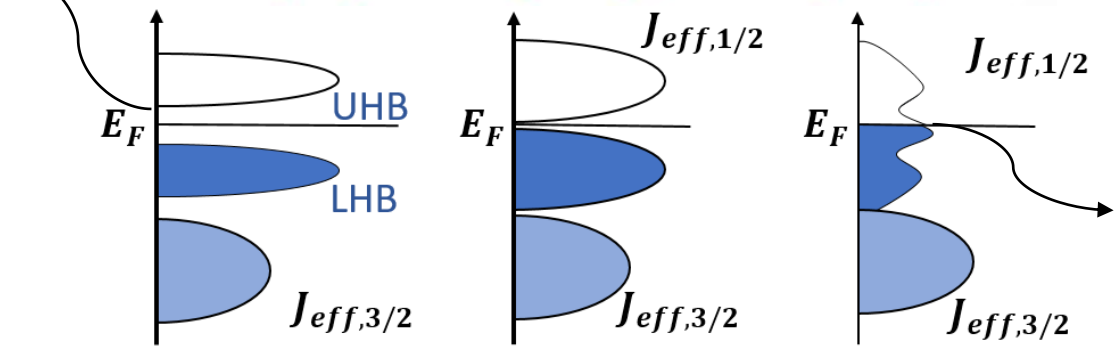


☆ $SrIrO_3$ ☆

n=∞



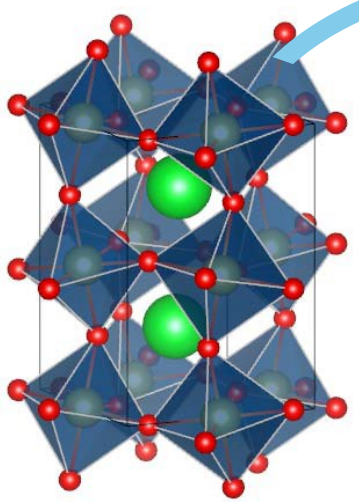
Mott insulator



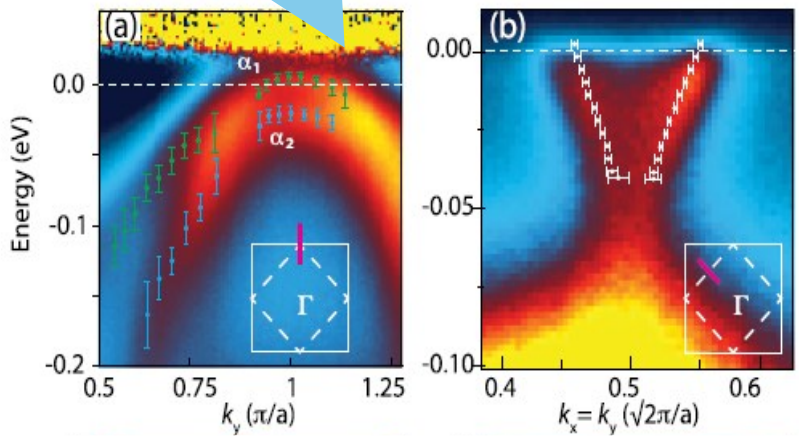
Metallic behavior at the edge of a metal-insulator transition

$SrIrO_3$

Narrow band semimetal



Octahedral rotations



Y. F. Nie et al. Phys. Rev. Lett. 114, 016401 (2015)

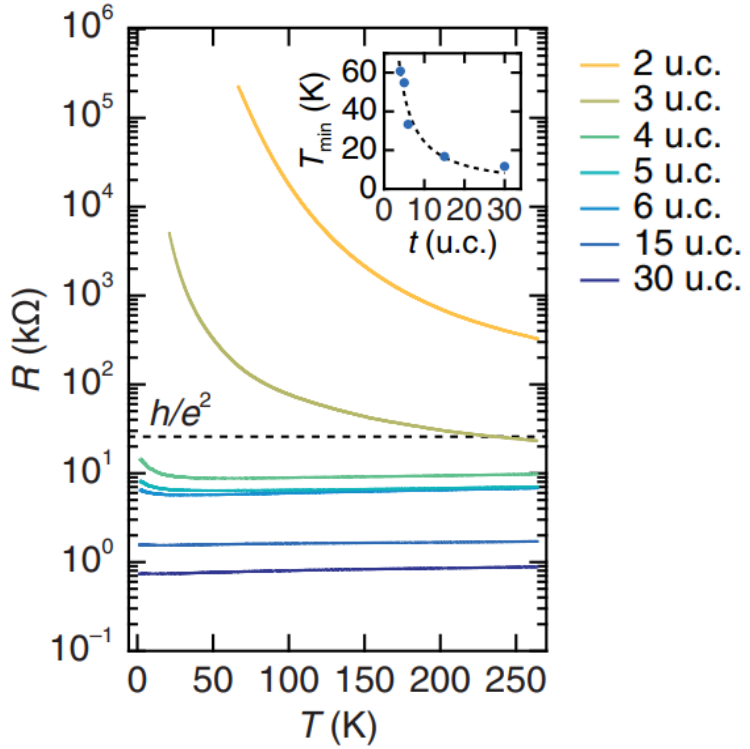
(0.3-0.4)

Spin-orbit coupling

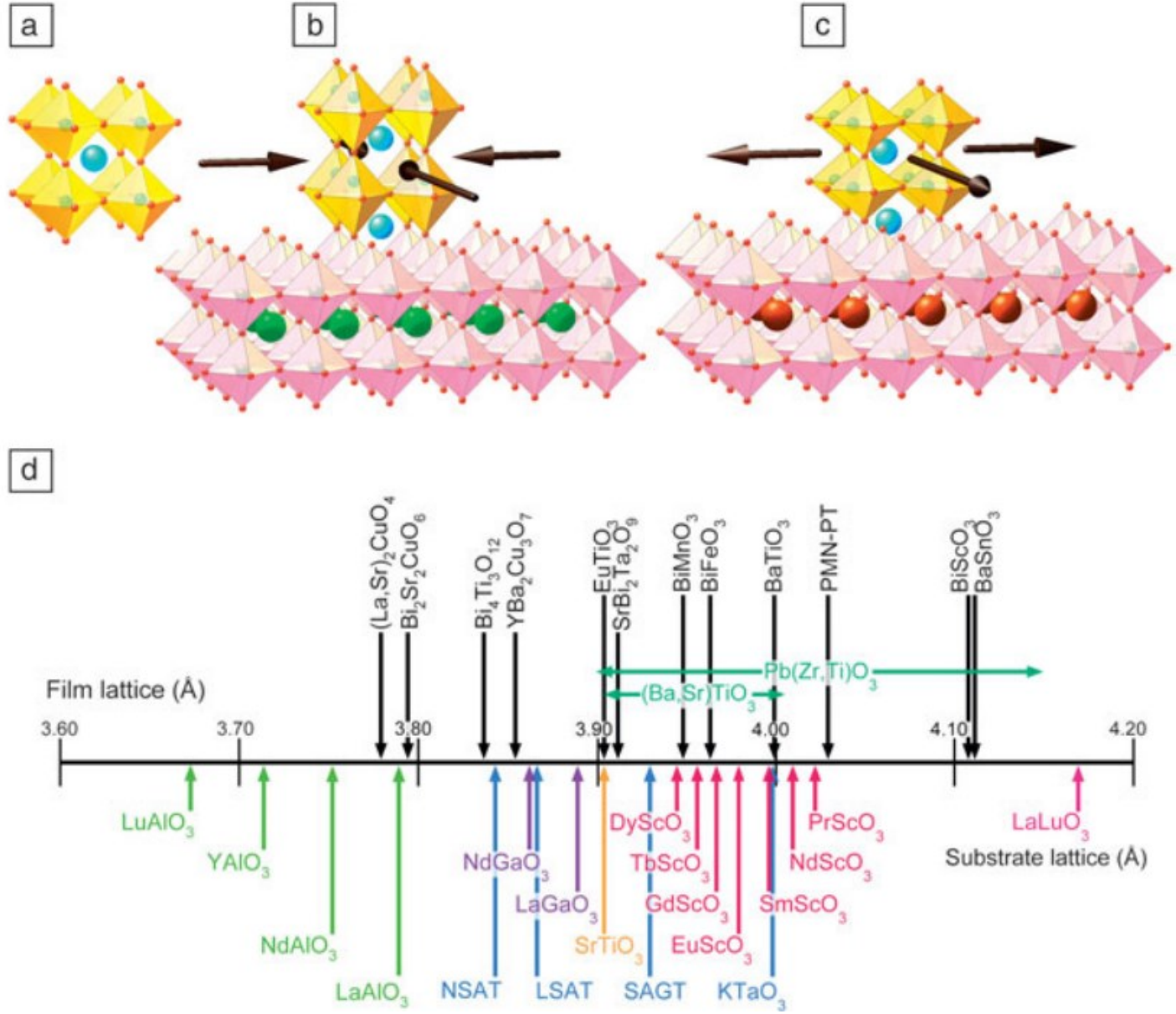
Electron correlations

Bandwidth

MIT on $SrTiO_3$

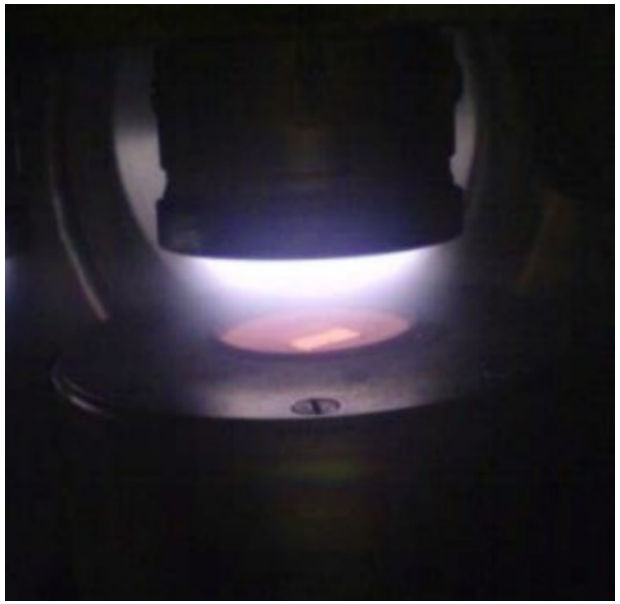


D. J. Groenendijk et al. Phys. Rev. Lett. 119, 256403 (2017)

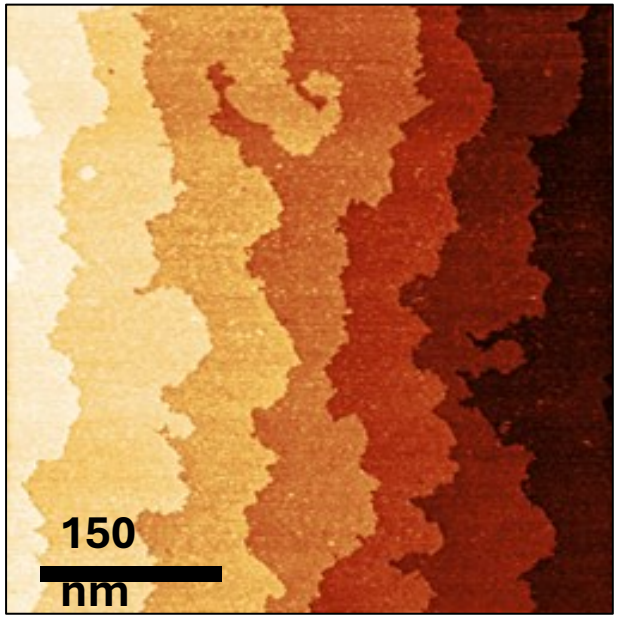

a
b
c
d
(La,Sr)2CuO4
Bi2Sr2CuO6
Bi4Ti3O12
YBa2Cu3O7
EuTiO3
SrBi2Ta2O9
BiMnO3
BiFeO3
BaTiO3
PMN-PT
BiScO3
BaSnO3
Pb(Zr,Ti)O3
(Ba,Sr)TiO3
Film lattice (Å)
3.60
3.70
3.80
3.90
4.00
4.10
4.20
LuAlO3
YAlO3
NdAlO3
LaAlO3
NSAT
NdGaO3
LSAT
LaGaO3
SrTiO3
DyScO3
TbScO3
GdScO3
EuScO3
SAGT
KTaO3
SmScO3
NdScO3
PrScO3
LaLuO3
Substrate lattice (Å)

Sample growth by high pressure sputtering

Oxygen plasma formed at the sputtering target

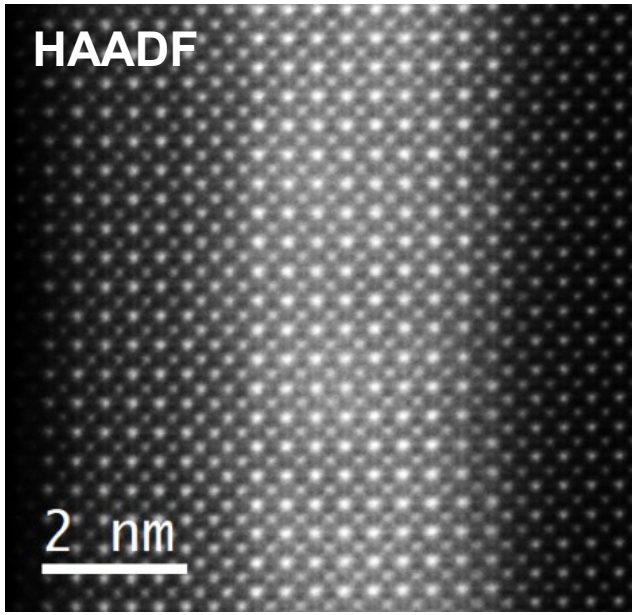


STM



$SrIrO_3$ (5 nm)

HR-STEM



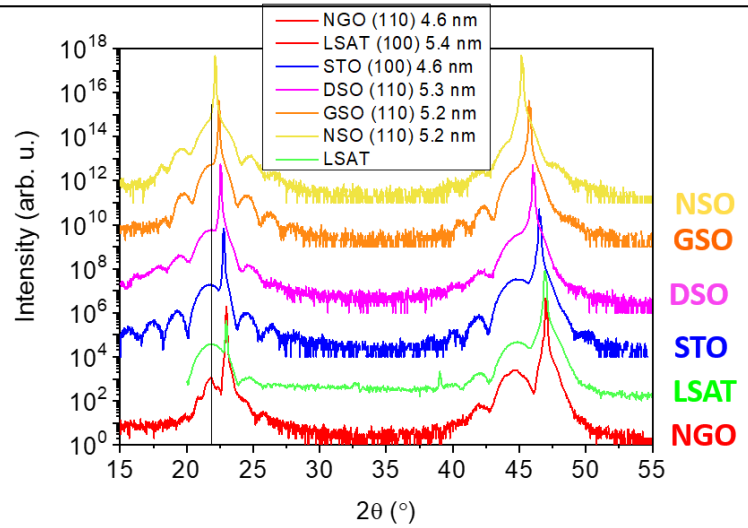
$La_{0.7}Sr_{0.3}MnO_3$ | $SrIrO_3$ | $SrTiO_3$ (001)
SUBSTRATE

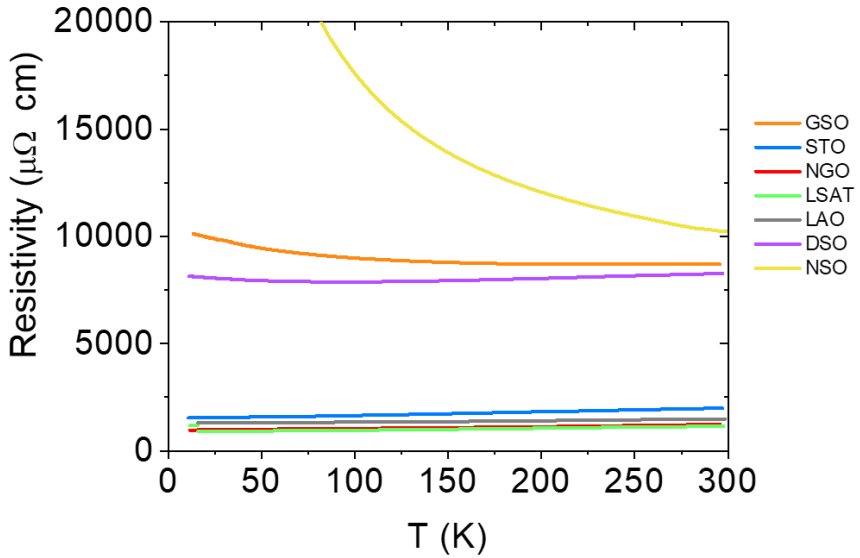
- High O_2 pressure: ~3 mBar
- Slow deposition rate: < 1 u.c./min
- High temperature: 900 °C
- 1-hour O_2 Annealing: 800 °C, 900 mbar

Flat epitaxial thin films with high crystalline quality

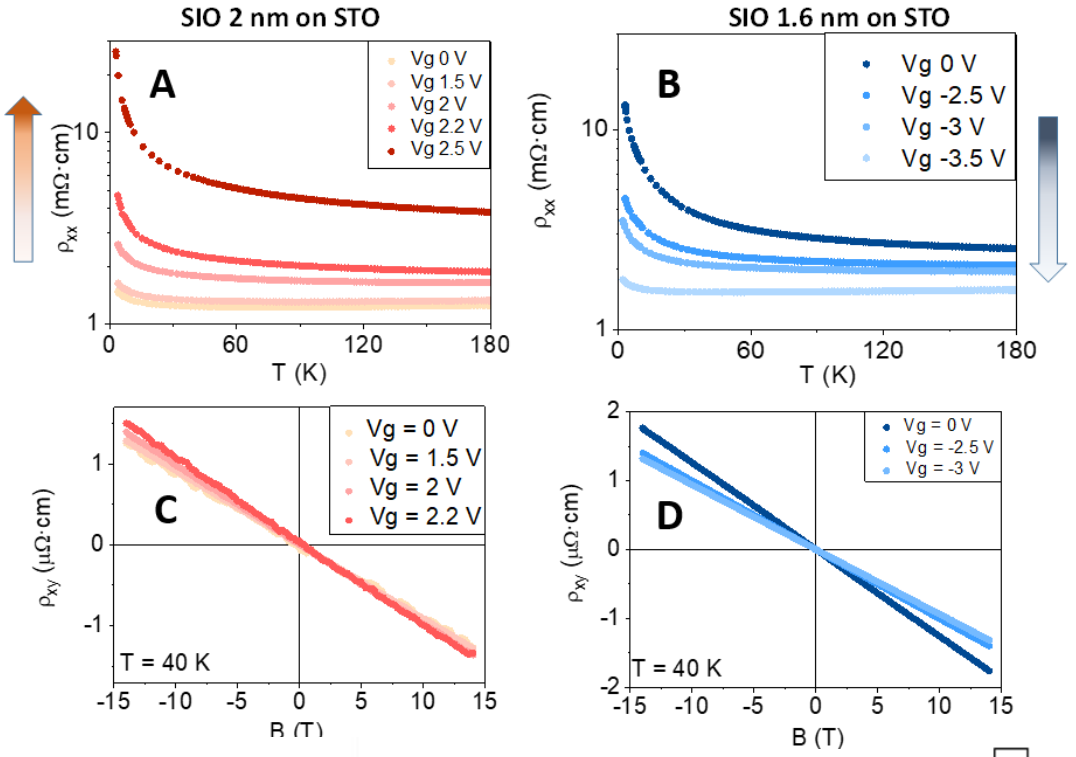
$SrIrO_3$ field effect experiments

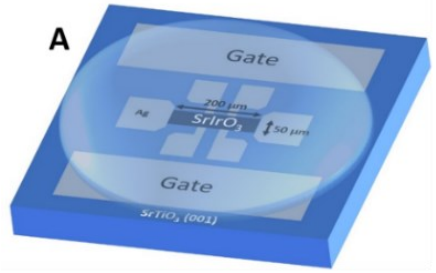
Transport properties as a function of the epitaxial strain



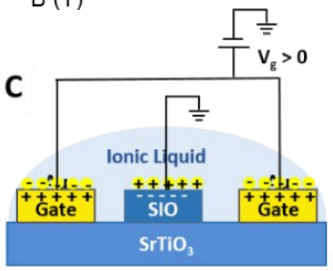


Transport properties under the effect of and electric field







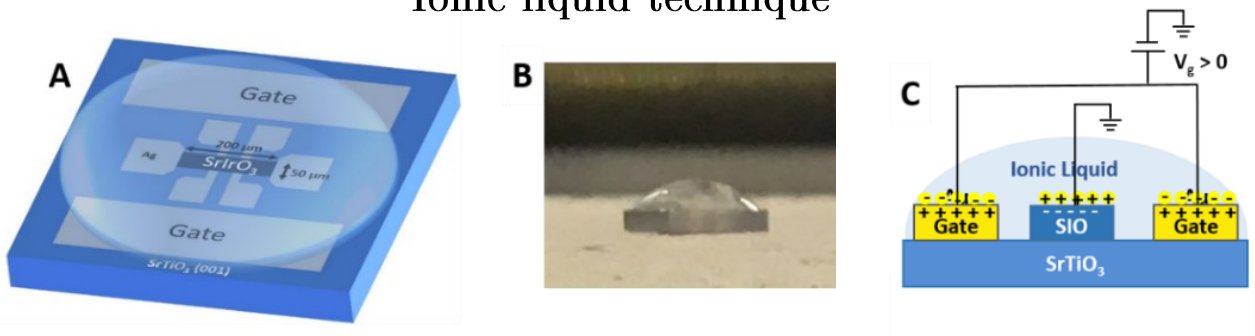


$SrIrO_3$ field effect experiments

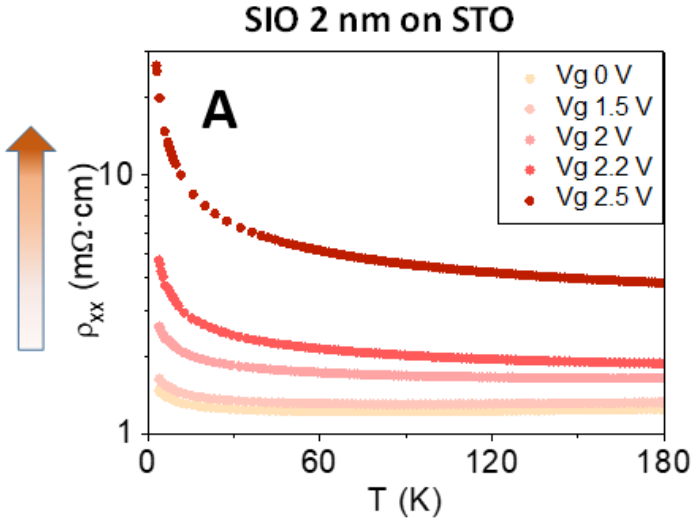
Transport properties under the effect of and electric field (part of Fernando Gallego's thesis)

Mª Carmen Muñoz
@ICMM
Juan Beltran @UCM

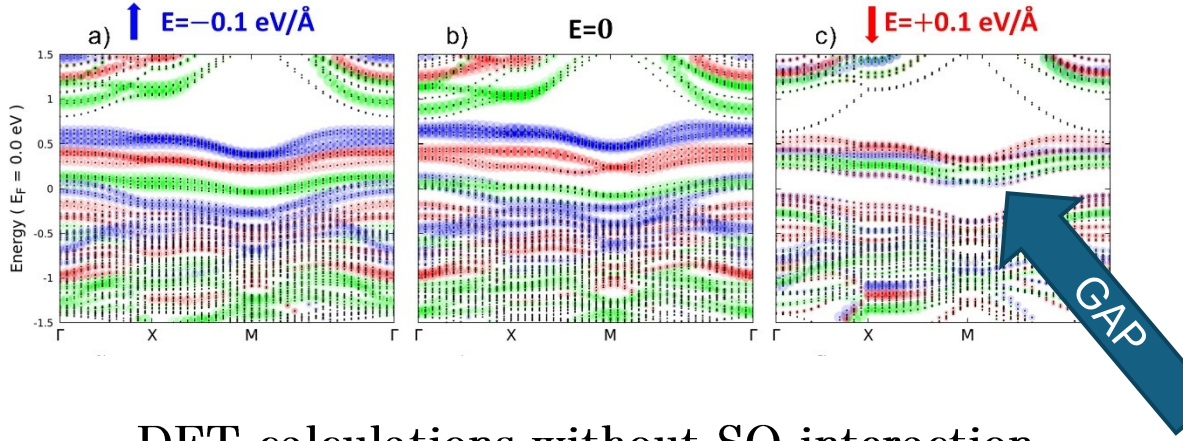
Ionic liquid technique



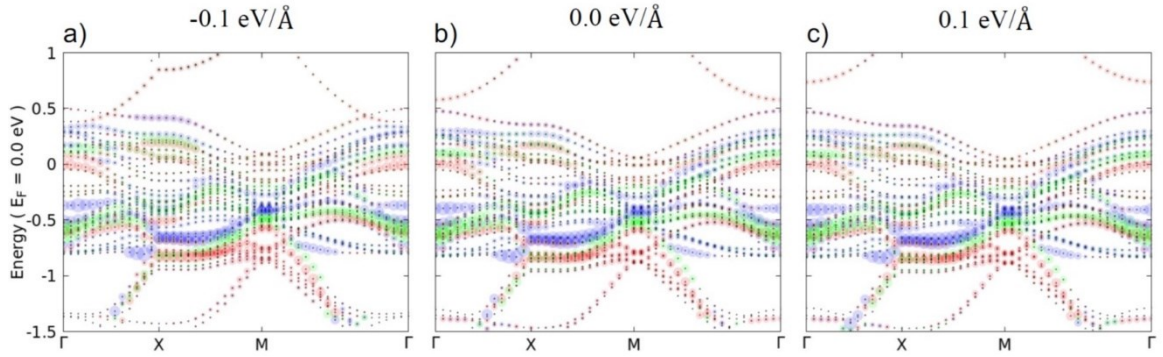
Field driven metal-insulator transition



DFT calculations

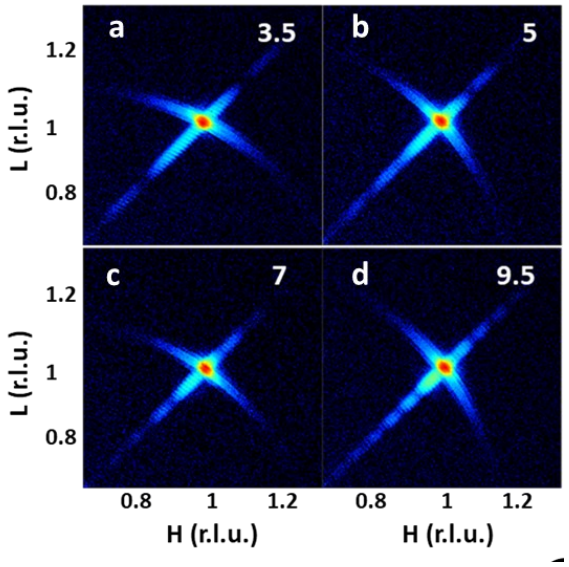


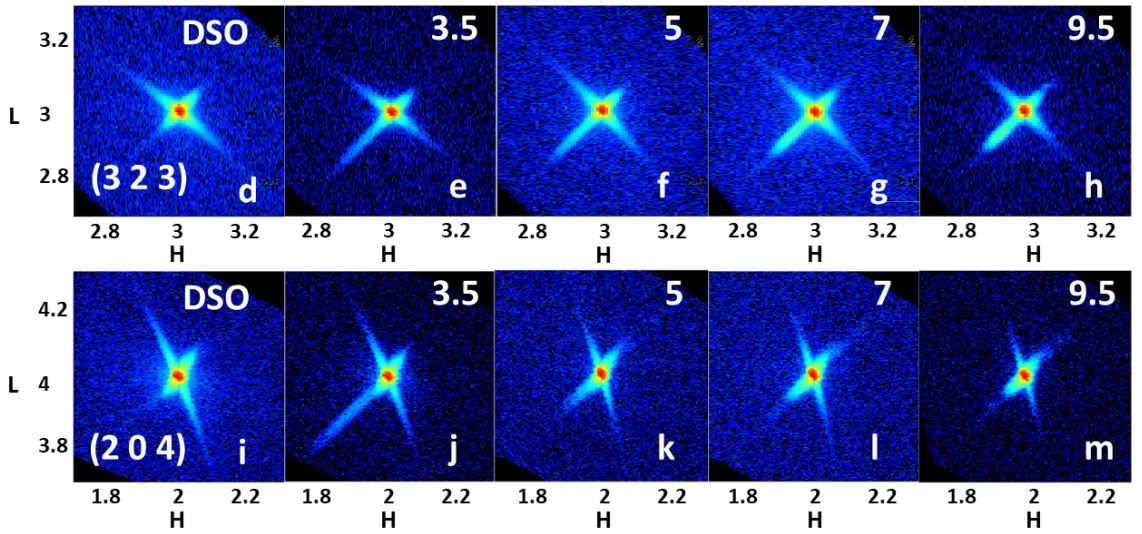
DFT calculations without SO interaction

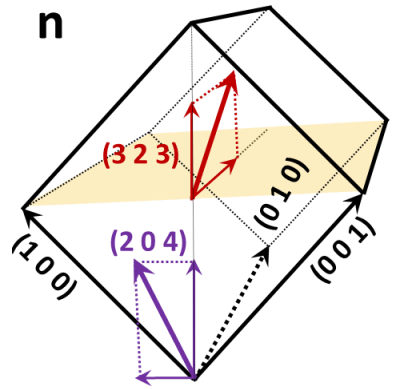


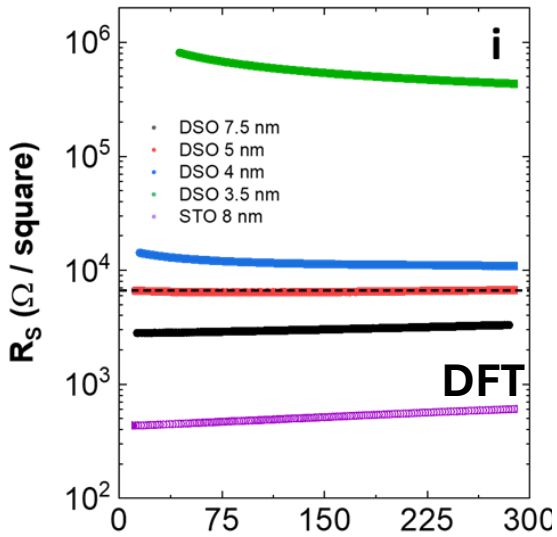
Gallego, F., et al. Commun Mater 4, 36 (2023)

$SrIrO_3$ strain effect experiments: growth on (101) $DyScO_3$

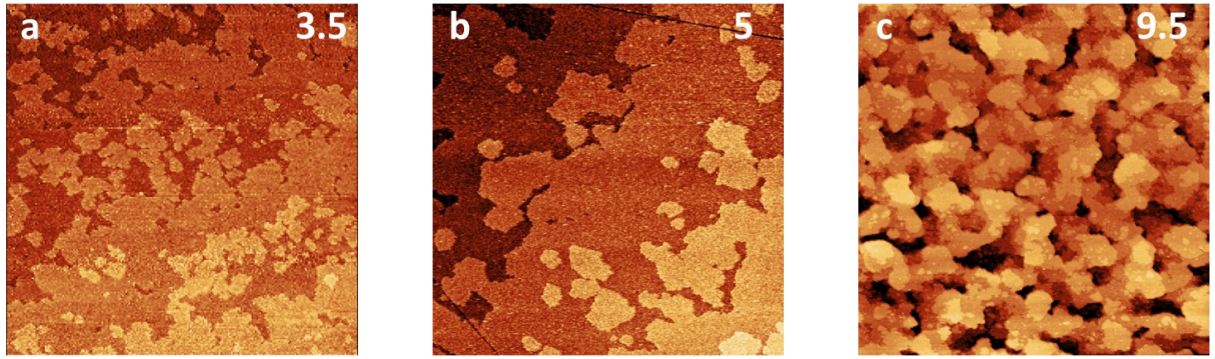


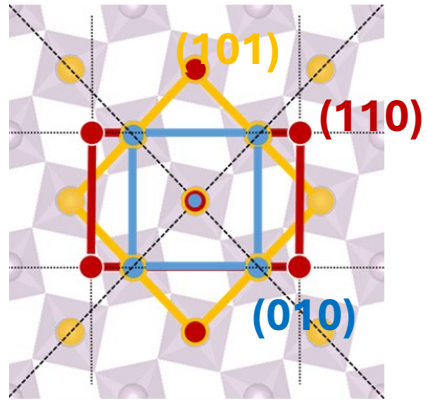




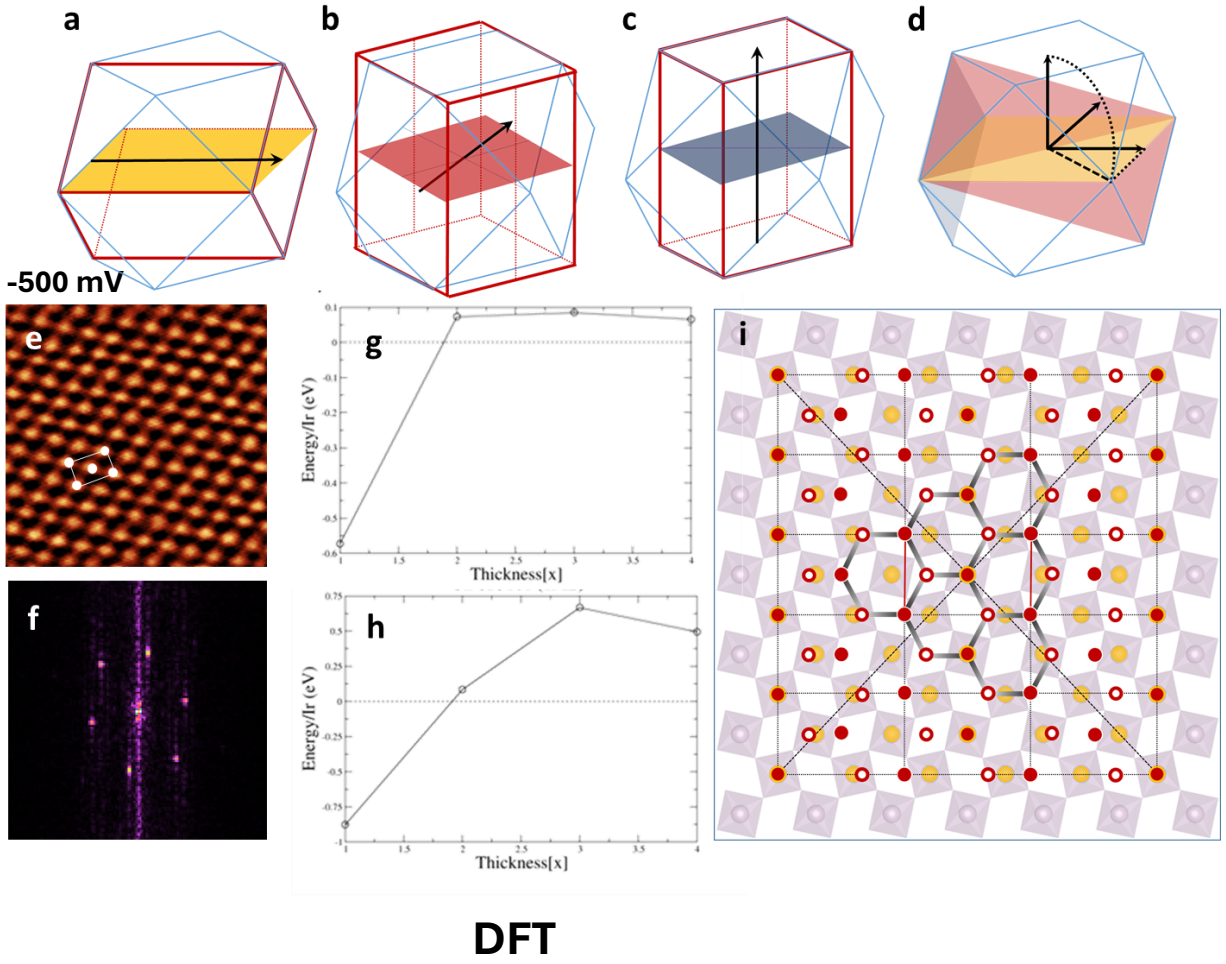


(101) (110) (010)



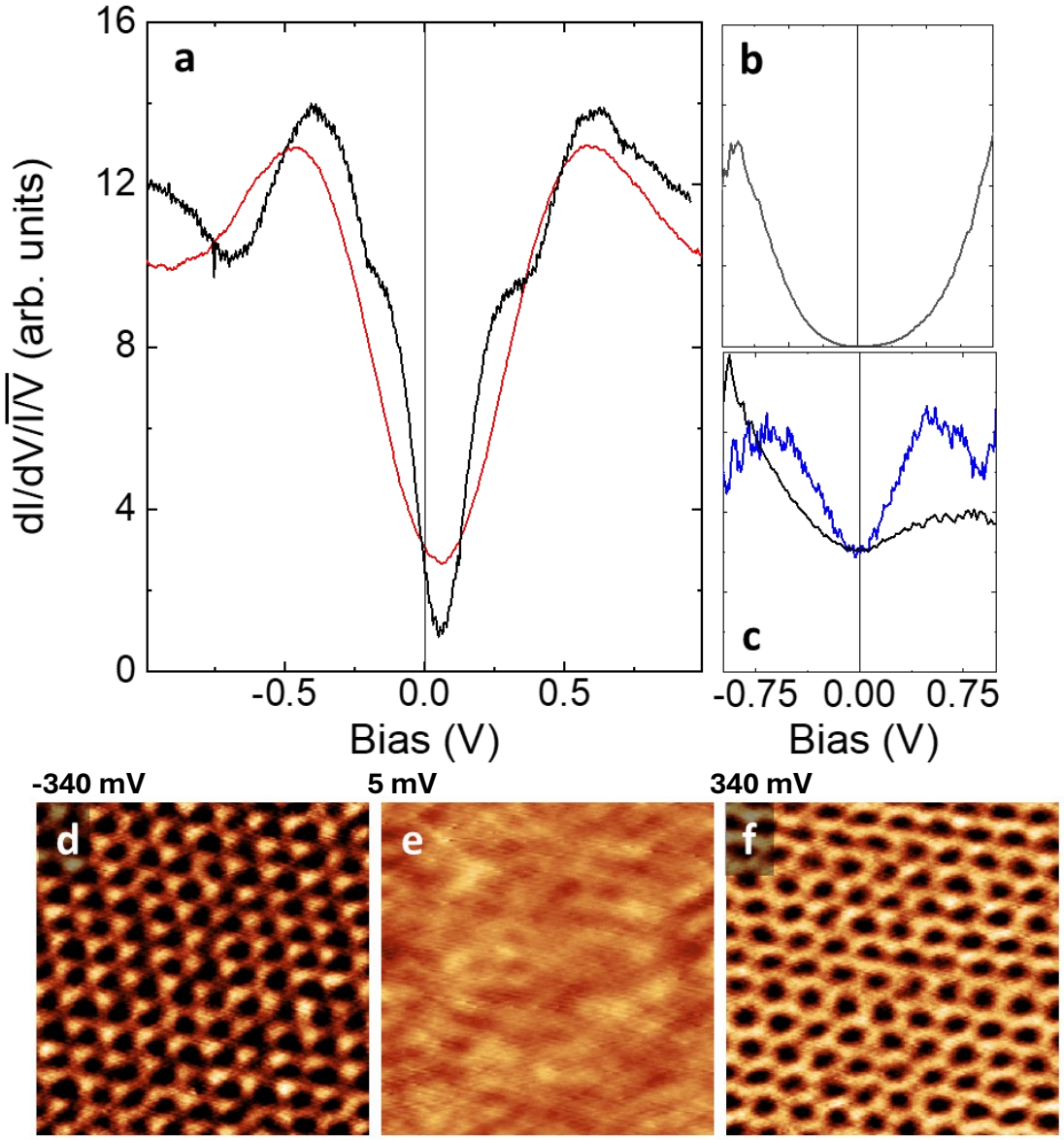


Stabilization of the monoclinic structure!

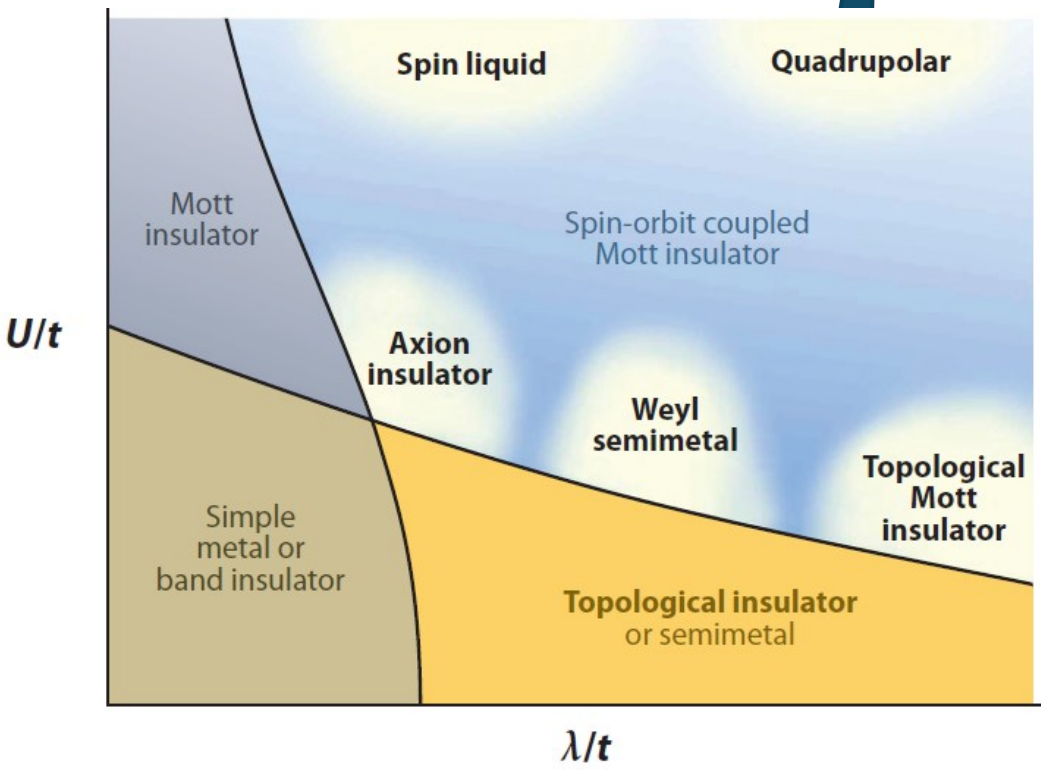


DFT

STS of the (110) pase: Dirac point!



Interfaces 3d/5d oxides



Witczak-Krempa et. al, Annu. Rev. Condens. Matter Phys. 5, 57–82 (2014).

Exotic electronic states

Strong electronic correlations (U/t)

+

Strong spin-orbit coupling (λ/t)

Interface engineering

$La_{0.7}Sr_{0.3}MnO_3$ → Correlated 3d oxide

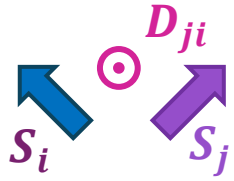
$SrIrO_3$ → 5d oxide with strong S.O. coupling

Magnetic textures

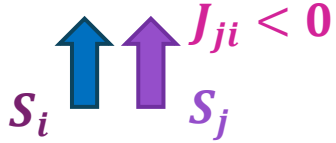
Interfaces 5d/3d

Spin-orbit coupling + Symmetry breaking

Dzyaloshinskii Moriya interaction (DMI)

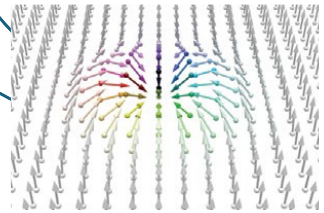


Heisenberg exchange



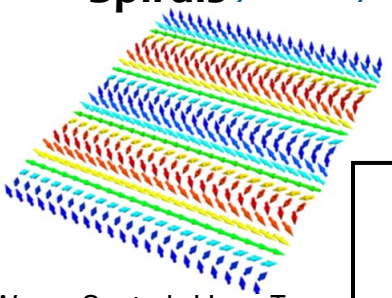
Dipolar interaction

Skyrmions



Trier, F., Noël, P., Kim, JV. *et al.* *Nat Rev Mater* 7, 258–274 (2022).

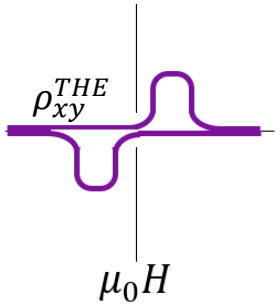
Spirals



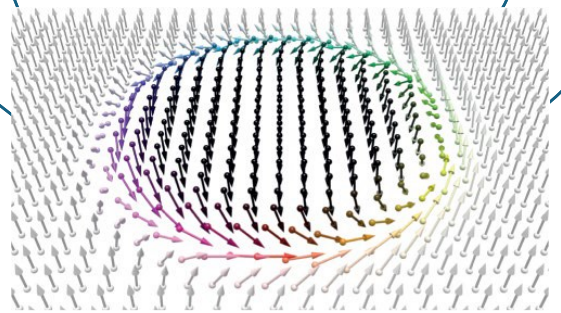
Wang, S. et al. J Low Temp Phys 197, 321–336 (2019)

Topological Hall effect

$$\rho_{xy}^{THE} = R_0 P \mathrm{n}_{\mathrm{eff}} \Phi_0$$



Bubbles

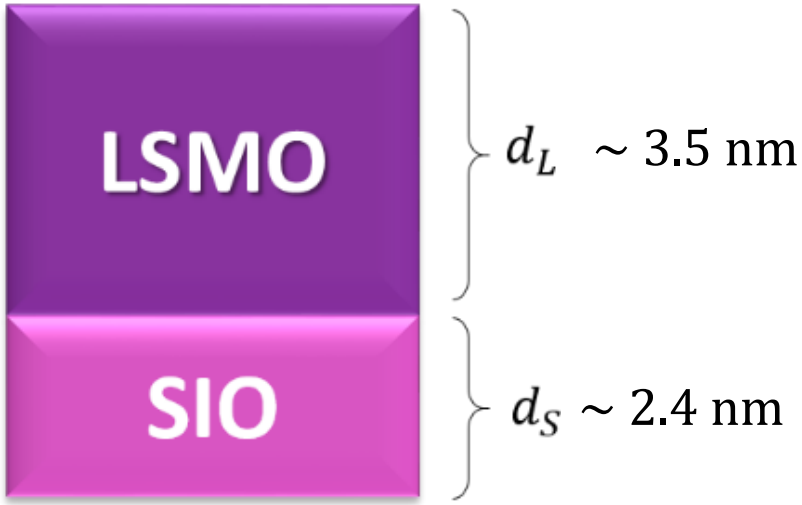


Trier, F., Noël, P., Kim, JV. *et al.* *Nat Rev Mater* 7, 258–274 (2022).

Sample and parameters

Theoretical background

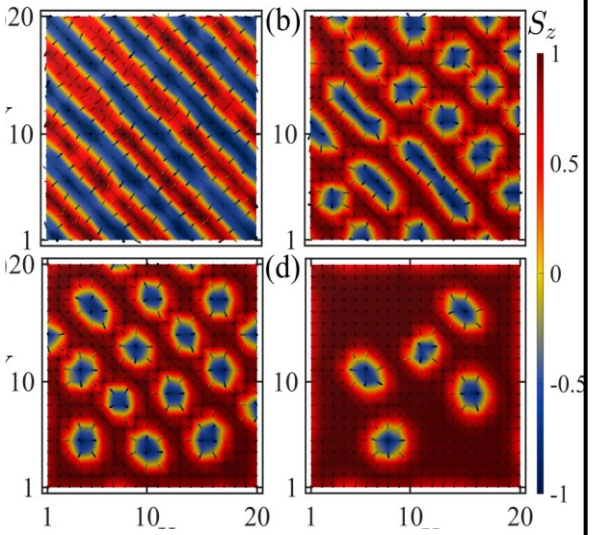
LSMO / SIO



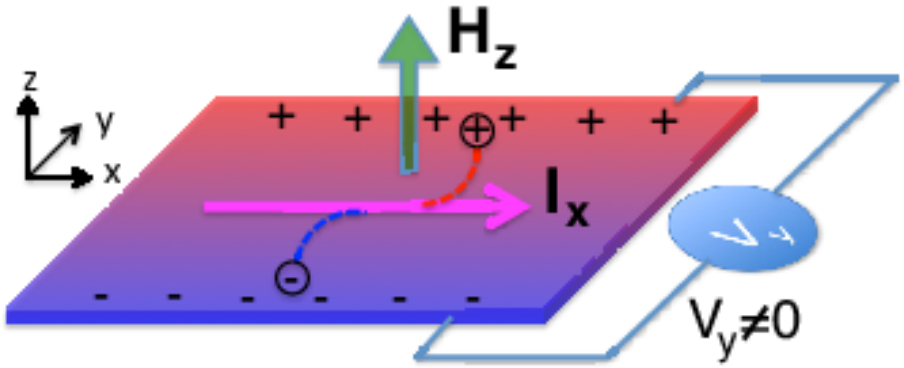
LSMO / SIO

Magnetic textures simulations

*Mohanta, Dagotto, and Okamoto Physical Review B **100**, 064429 (2019)*



Hall effect



Ordinary Hall effect

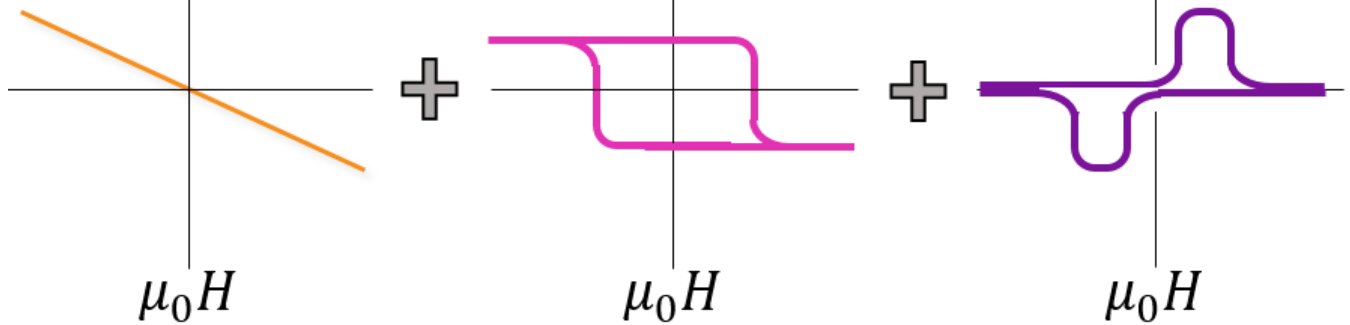
$$\rho_{xy}^{OHE} = R_0 H_z$$

Anomalous Hall effect

$$\rho_{xy}^{AHE} = R_s M_z$$

Topological Hall effect

$$\rho_{xy}^{THE} = R_0 P \mathrm{n}_{\mathrm{eff}} \Phi_0$$



- $\boldsymbol{\rho_{xy}}$ can be written in terms of $\boldsymbol{\sigma_{xy}}$ and $\boldsymbol{\rho_{xx}^2}$

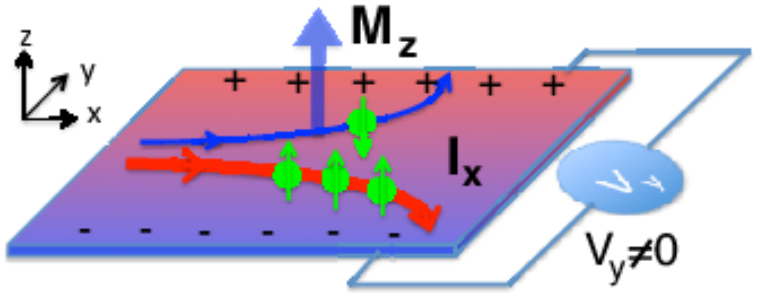
$$\sigma = \rho^{-1} = \begin{vmatrix} \rho_{xx} & \rho_{xy} \\ \rho_{xy} & \rho_{xx} \end{vmatrix}^{-1} = \frac{1}{\rho_{xy}^2 + \rho_{xx}^2} \begin{pmatrix} \rho_{xx} & -\rho_{xy} \\ -\rho_{xy} & \rho_{xx} \end{pmatrix}$$

$$\begin{pmatrix} \sigma_{xx} & \sigma_{xy} \\ \sigma_{xy} & \sigma_{xx} \end{pmatrix} = \frac{1}{\rho_{xy}^2 + \rho_{xx}^2} \begin{pmatrix} \rho_{xx} & -\rho_{xy} \\ -\rho_{xy} & \rho_{xx} \end{pmatrix}$$

$$\sigma_{xy} = \frac{\rho_{xy}}{\rho_{xy}^2 + \rho_{xx}^2} \rightarrow \sigma_{xy} \approx \frac{\rho_{xy}}{\rho_{xx}^2} \rightarrow \boldsymbol{\rho_{xy} \approx \sigma_{xy} \cdot \rho_{xx}^2}$$

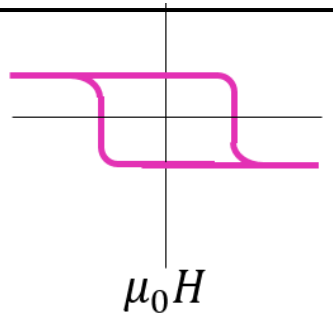
where $\sigma_{xy} = \sigma_{xy}^{OHE} + \sigma_{xy}^{AHE} + \sigma_{xy}^{THE}$

AHE

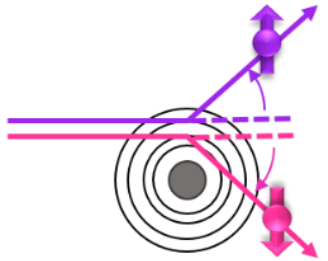


Anomalous Hall effect

$$\rho_{xy}^{AHE} = R_s M_z$$



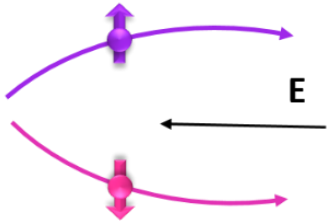
Extrinsic mechanism



Scattering dependent

$$\rho_{xy} \approx \sigma_{xy}^{AHE,ext} \cdot \rho_{xx}$$

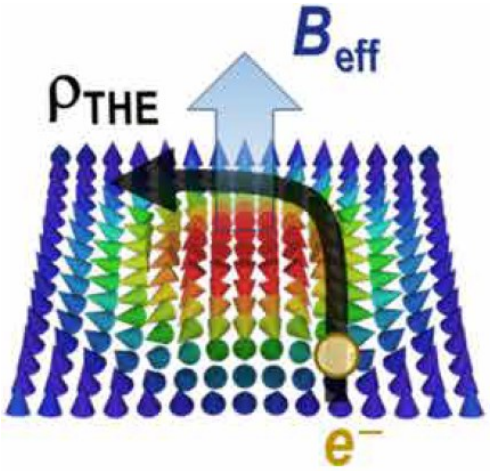
Intrinsic mechanism



Scattering independent

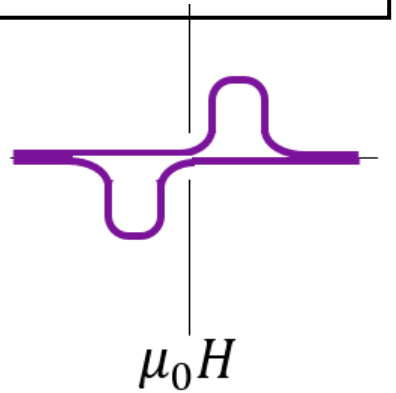
$$\rho_{xy} \approx \sigma_{xy}^{AHE,int} \cdot \rho_{xx}^2$$

THE



Topological Hall effect

$$\rho_{xy}^{THE} = R_0 P n_{eff} \Phi_0$$

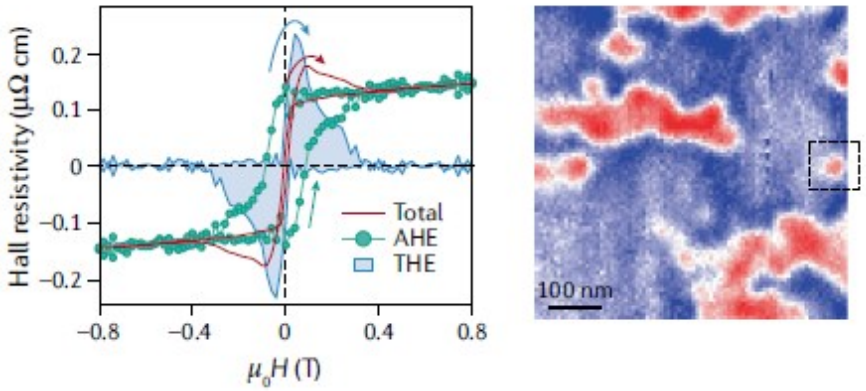


$\boldsymbol{n_{eff}}$ = effective number of skyrmions and bubbles
$\boldsymbol{R_0}$ = Ordinary Hall coefficient
$\boldsymbol{P}$ = Spin polarization
Φ_0= magnetic flux quantum

Bruno, Phys Rev Lett (2004)

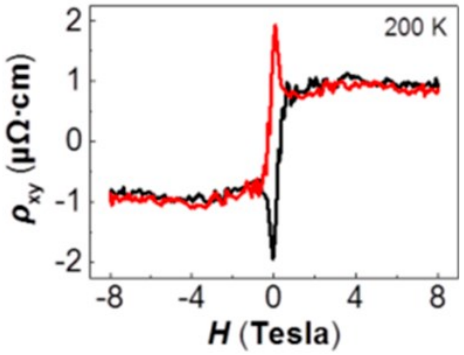
Magnetic textures in correlated oxides

$SrRuO_3$(5 u.c.)/$SrIrO_3$(2 u.c.)



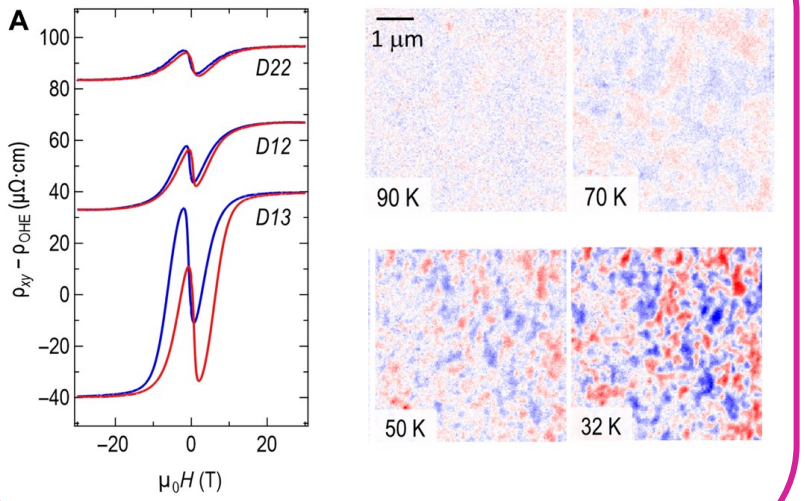
Matsuno, J. et al. Sci. Adv. ***2*** *(2016)*

$La_{0.7}Sr_{0.3}MnO_3$(8 u.c.)/$SrIrO_3$(2 u.c.)



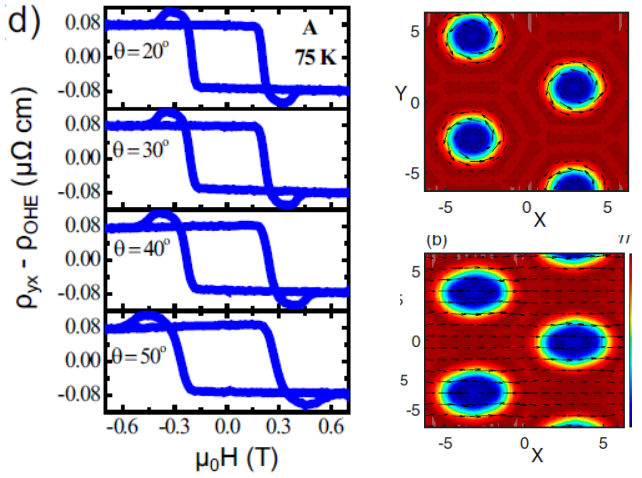
Yao Li et al. ACS Appl. Mater. Interfaces (2019), 11, 23

$[(LaMnO_3)_n/(SrIrO_3)_n]_m$



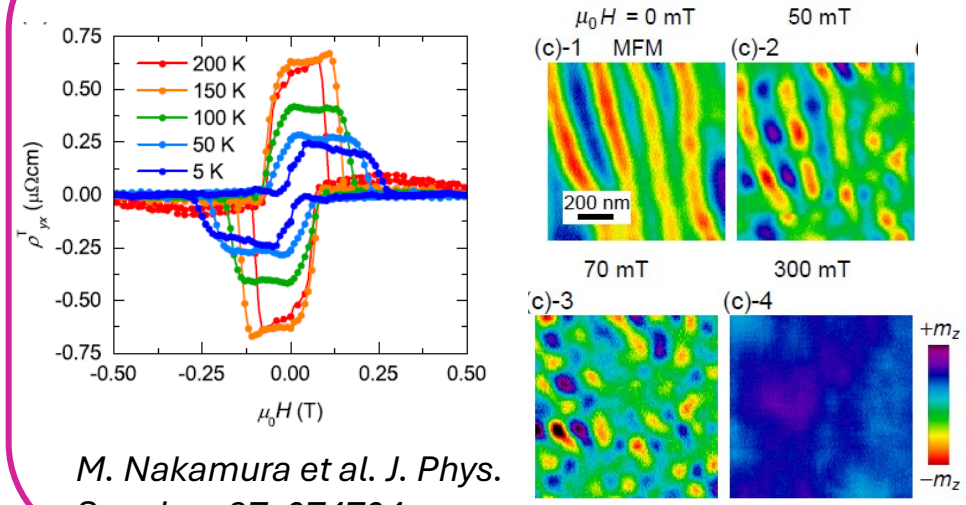
Skoropata E et al. Sci Adv. (2020)

$SrRuO_3$



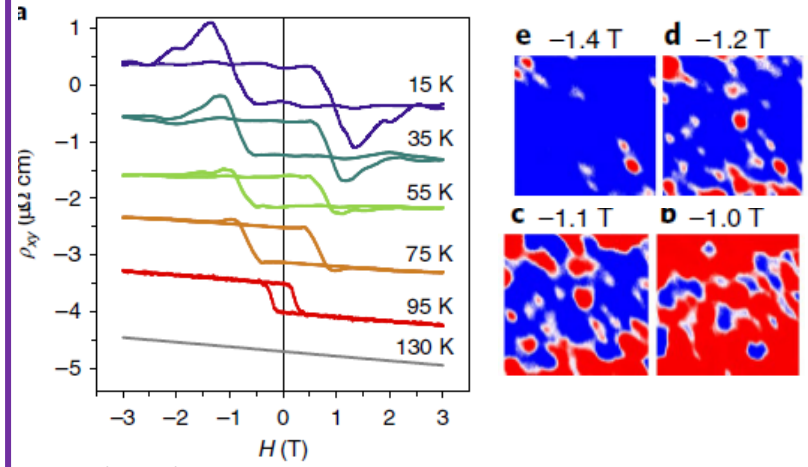
P. Zhang, Phys. Rev. Research 2, 032026(R)

Lao.7Sro.3Mn1-yRuyO3



M. Nakamura et al. J. Phys. Soc. Jpn. 87, 074704 (2018)

Cao.96Ceo.04MnO3

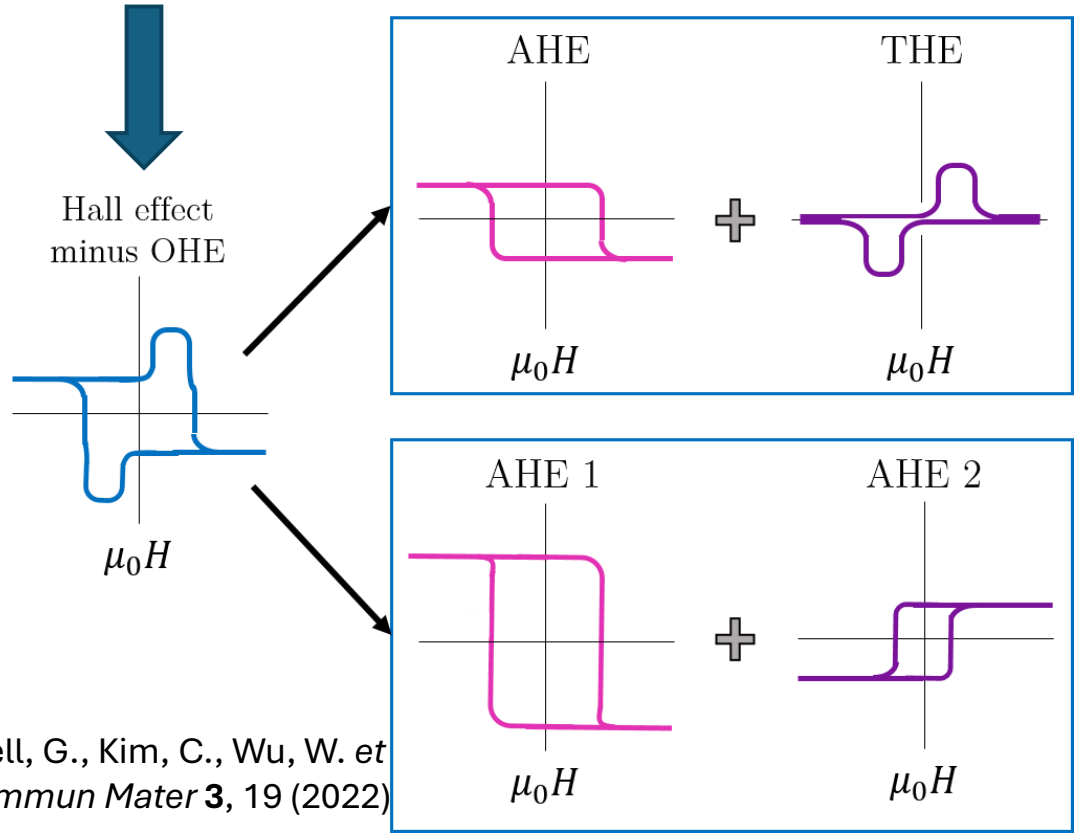


Vistoli, L., Wang, W., Sander, A. et al. Nature Phys ***15****, 67–72 (2019)*

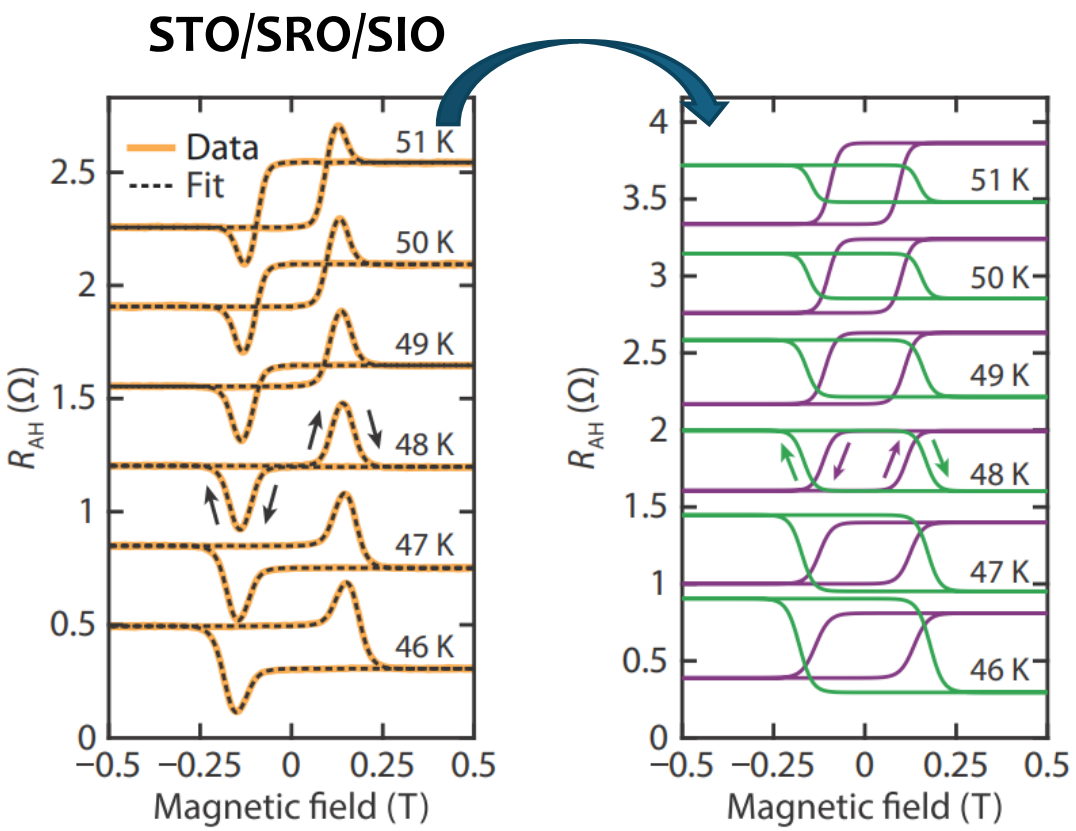
The debate

(1) Discrepancies between the skyrmion densities obtained from THE and microscopy observations.

(2) Inhomogeneities may yield inhomogeneous multicomponent anomalous Hall effect which can be mistaken with THE. (TC van Thiel *et al* 2020 *J. Phys. Mater.*) (Groenendijk, D. J. et al. Phys. Rev. Res. 2, (2020))

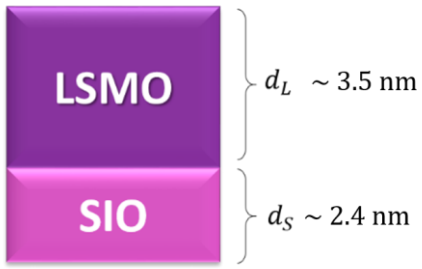


Kimbell, G., Kim, C., Wu, W. *et al*. *Commun Mater* **3**, 19 (2022)

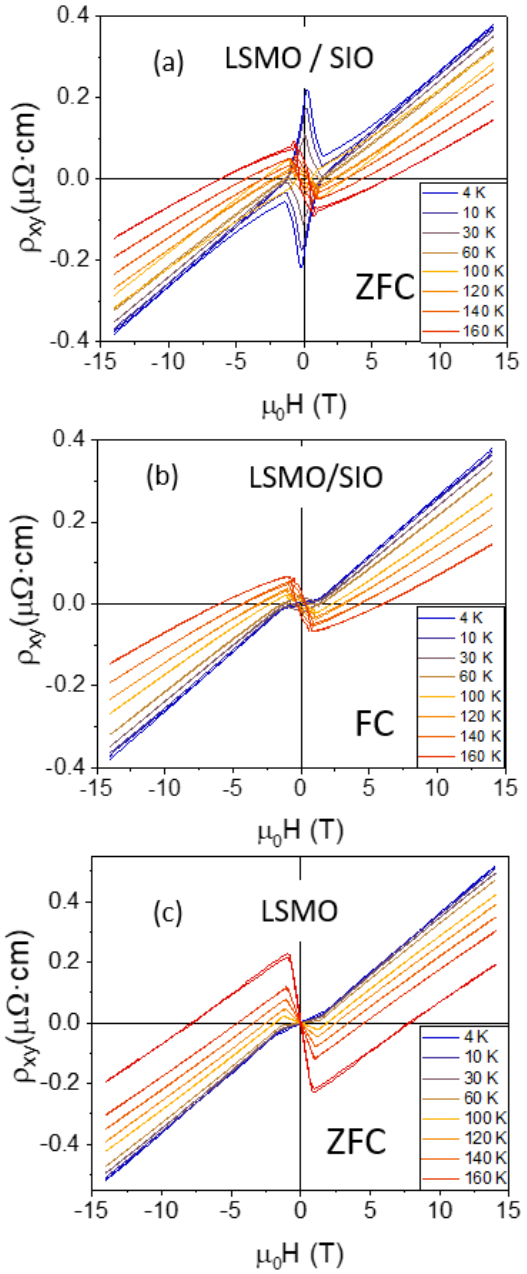


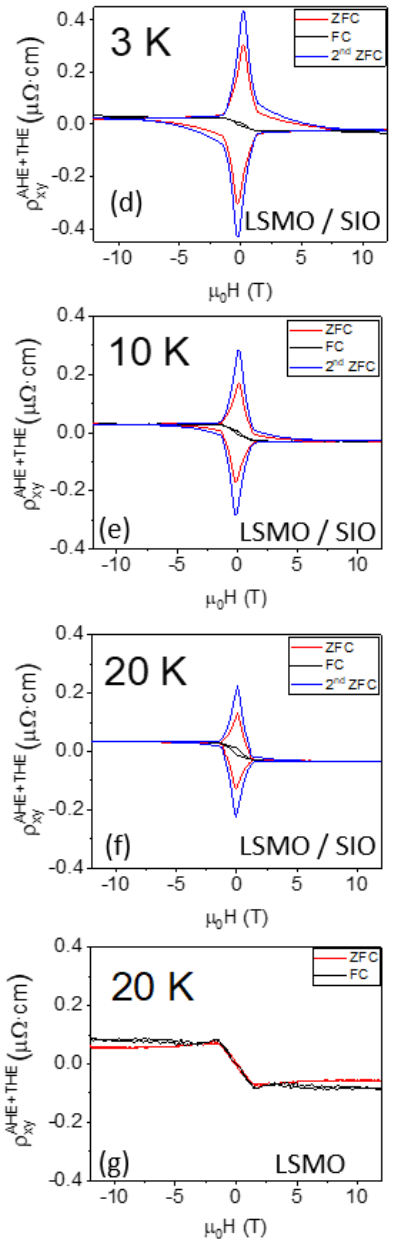
MAGNETIC HISTORY DEPENDENT TOPOLOGICAL HALL EFFECT

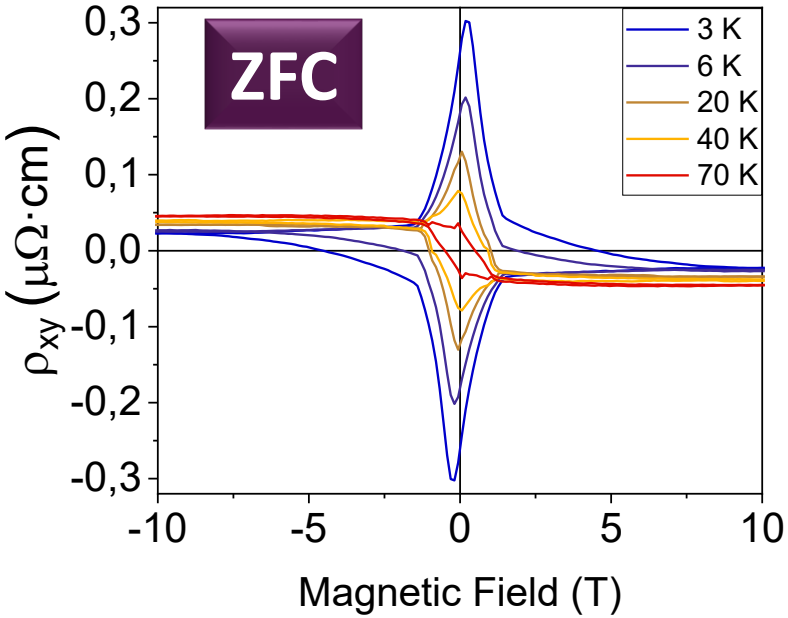
LSMO / SIO







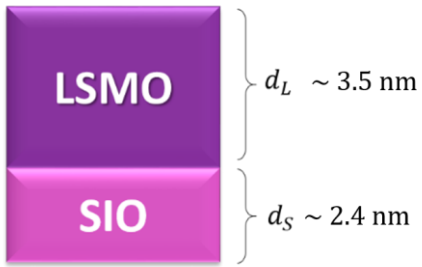




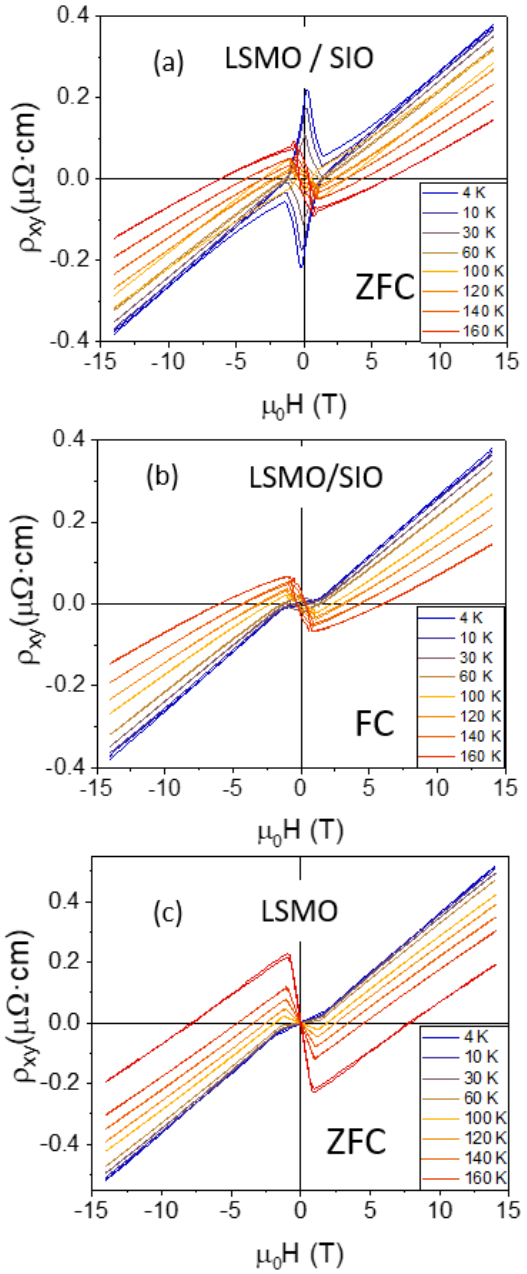
A. Peralta Comms. Mater (2026)
Doi 10.1038/s43246-026-01255-1

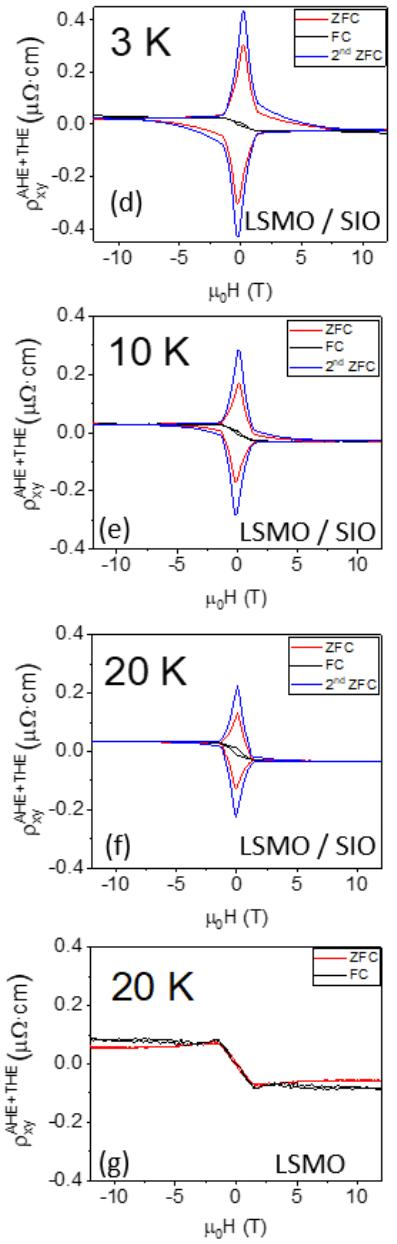
MAGNETIC HISTORY DEPENDENT TOPOLOGICAL HALL EFFECT

LSMO / SIO

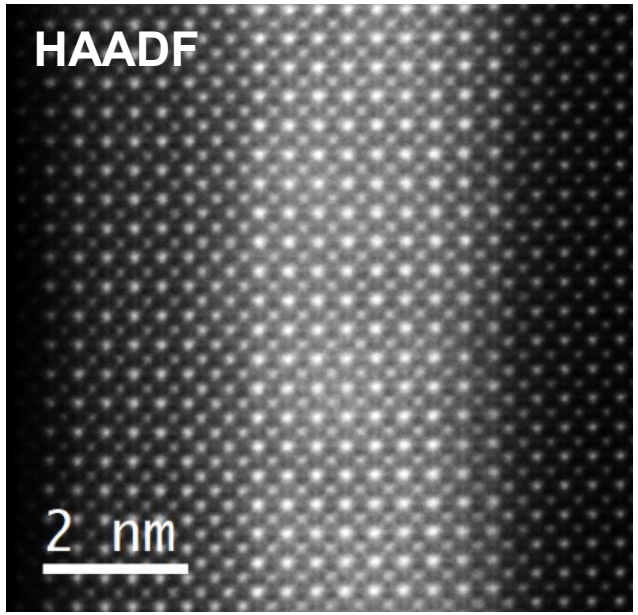








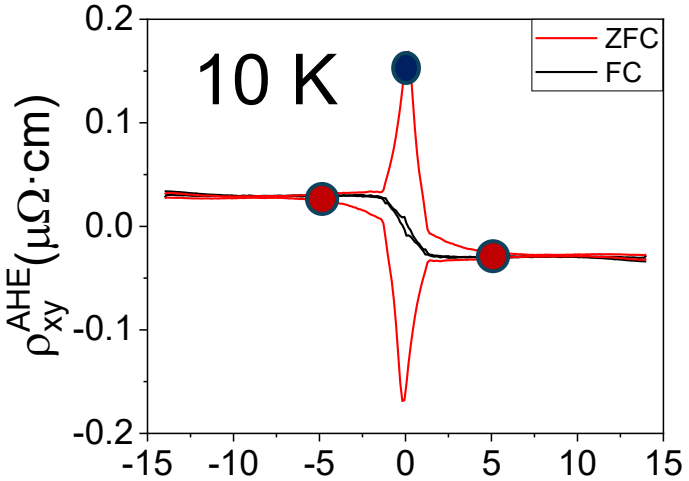
HR-STEM

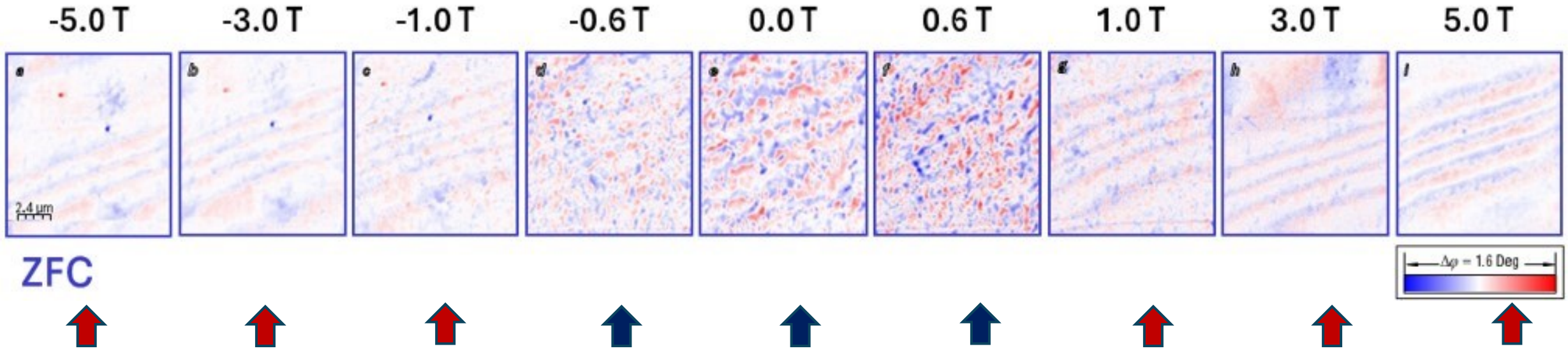


$La_{0.7}Sr_{0.3}MnO_3$ | $SrIrO_3$ | $SrTiO_3$ (001)
SUBSTRATE

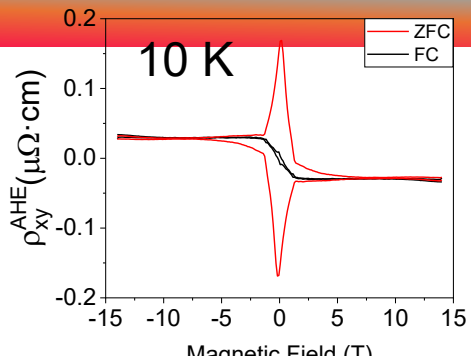
A. Peralta Comms. Mater (2026)
Doi 10.1038/s43246-026-01255-1

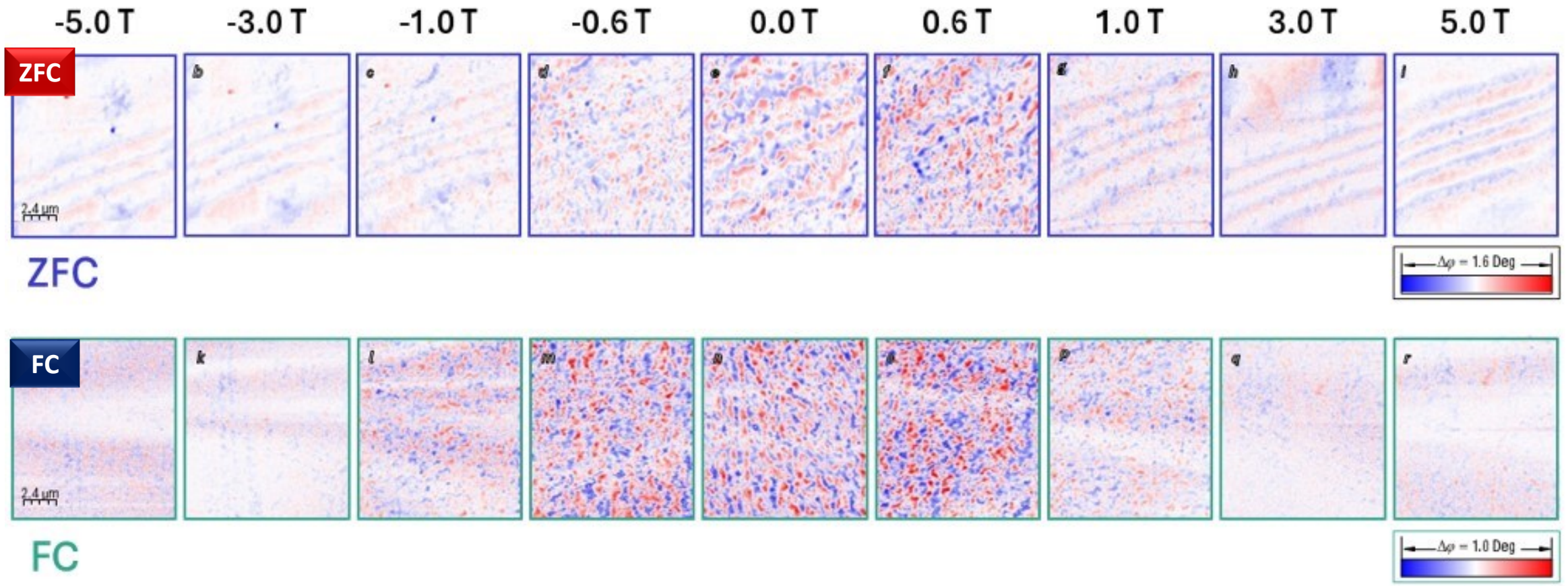
MFM study at ZFC/FC





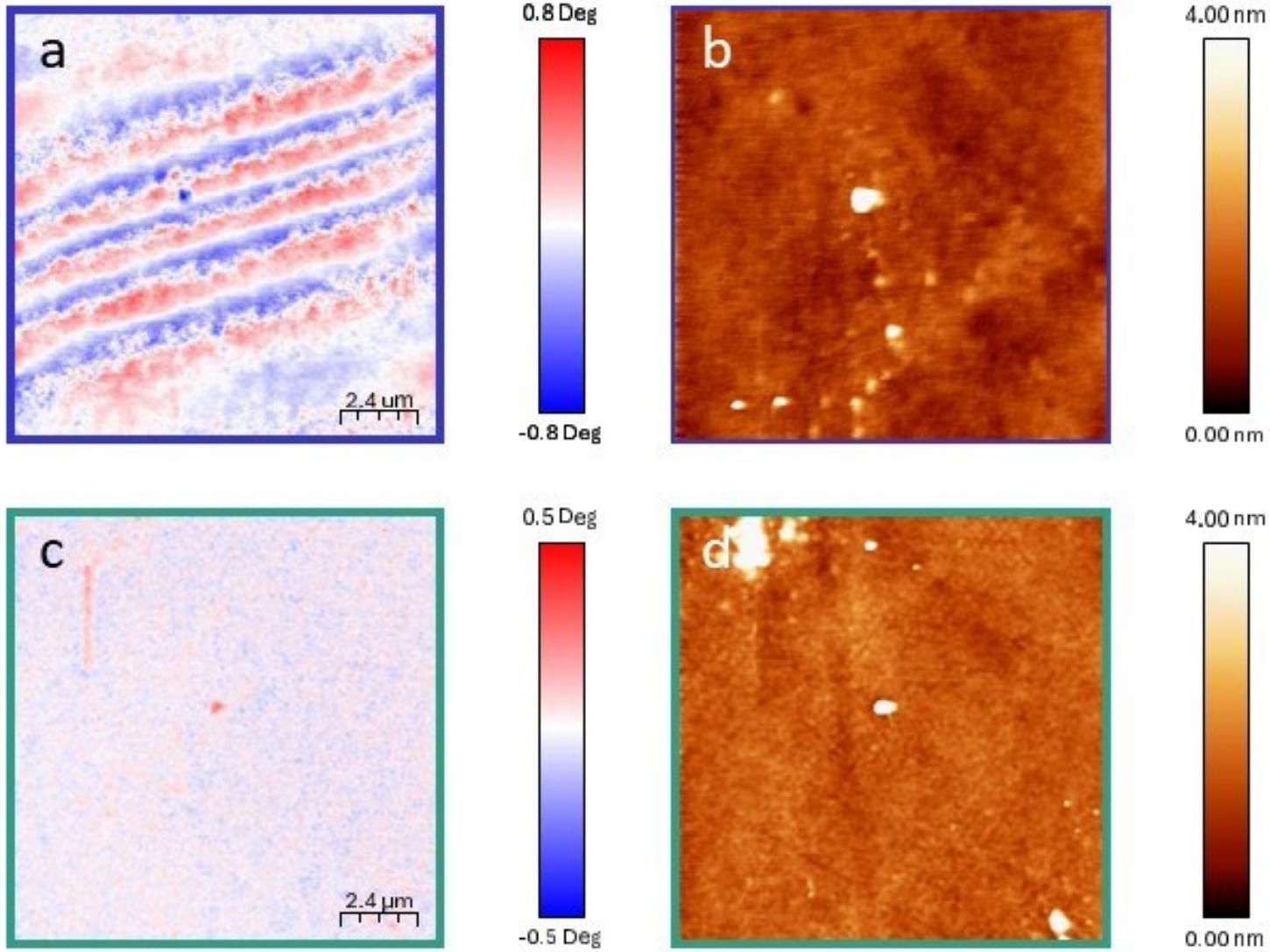
MFM study at ZFC/FC





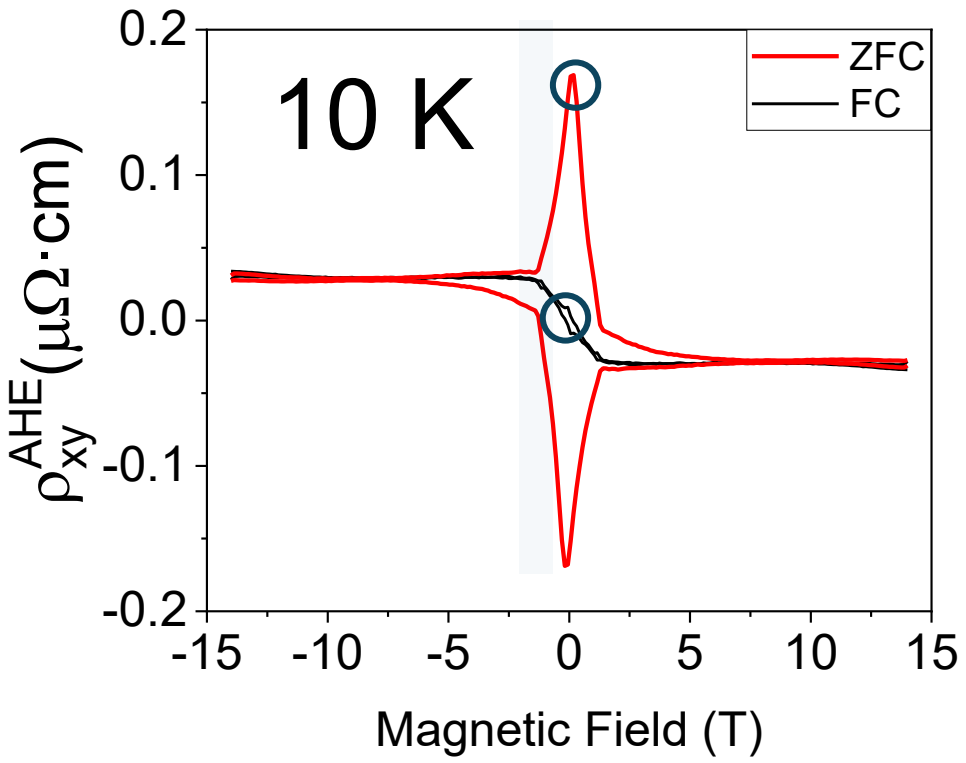
ZFC

FC


a
2.4 um
0.8 Deg
-0.8 Deg
b
4.00 nm
0.00 nm
c
2.4 µm
0.5 Deg
-0.5 Deg
d
4.00 nm
0.00 nm

MFM study at ZFC/FC

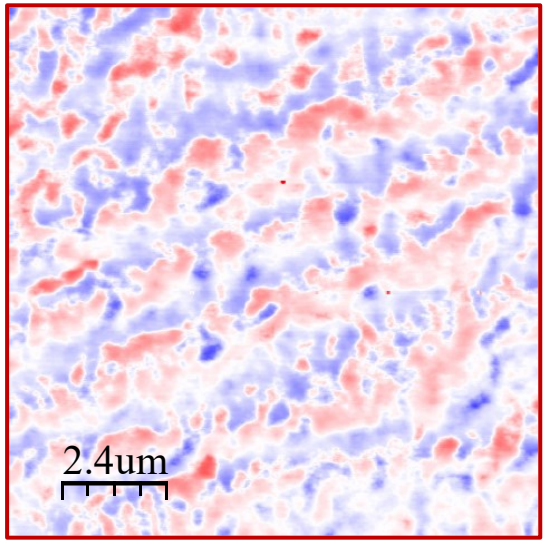
Large THE emerge after the ZFC and disappear after the FC at 14T,



ZFC

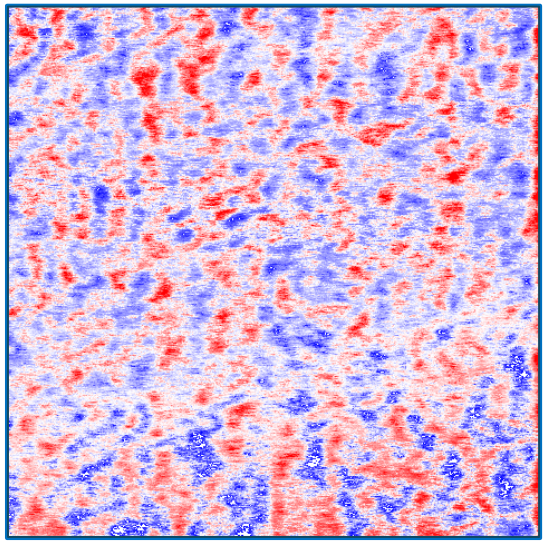
Magnetic textures slightly oriented in fringes

B=0 T T= 17 K



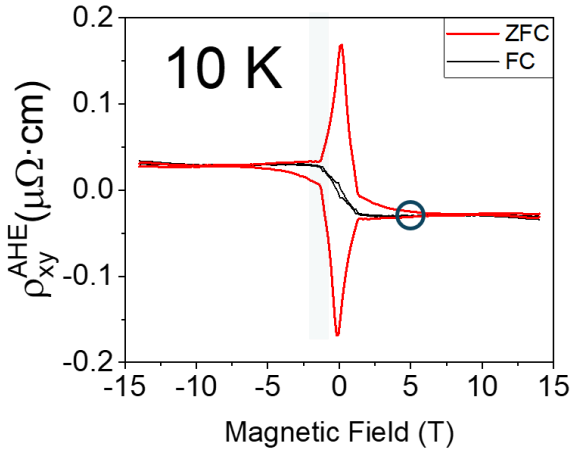
FC

Magnetic textures without any preferential orientation



MFM study at ZFC/FC

Spirals are observed at 5 T after ZFC but disappear after FC,

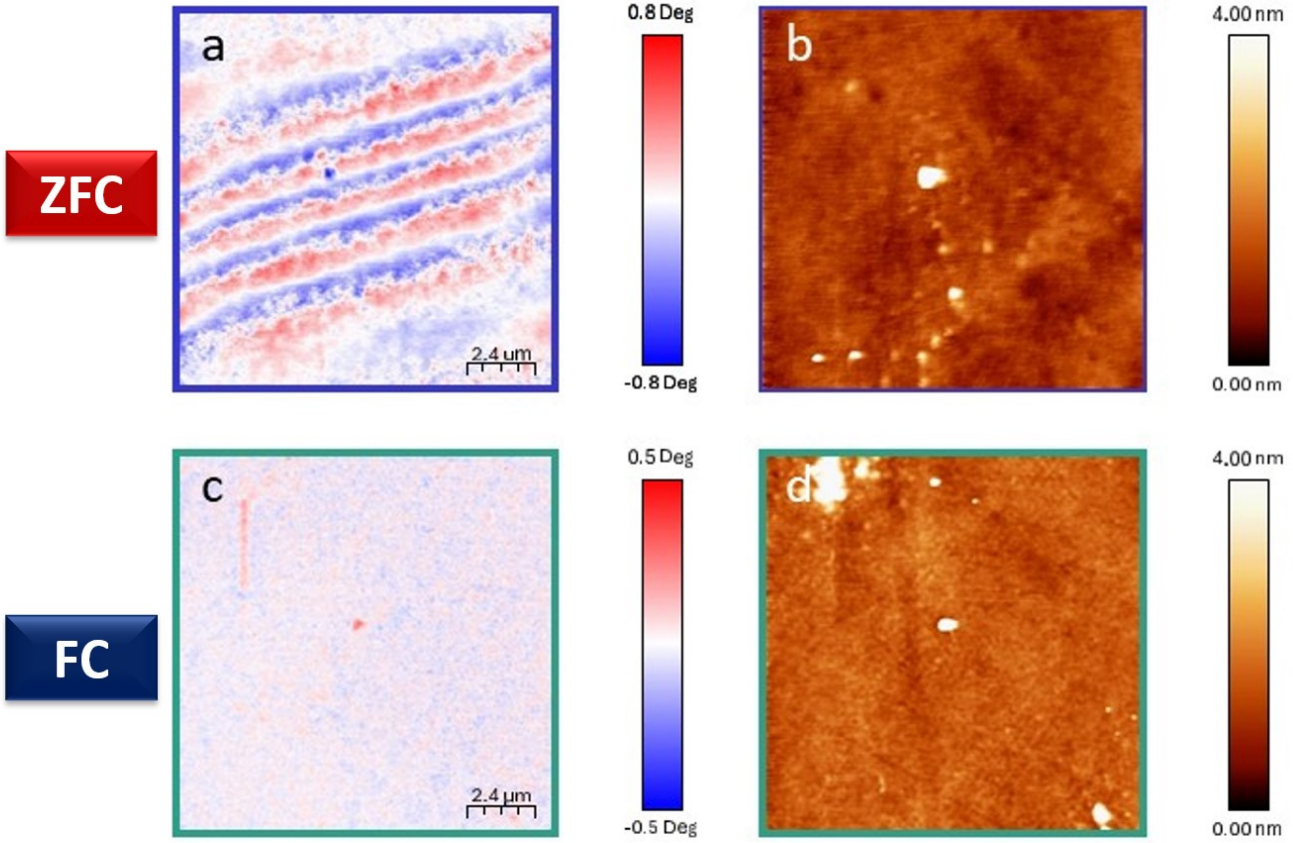


$$A = 1\ pJm^{-1}$$

$$L \sim 4\pi \frac{A}{D} \qquad D \sim 6\ \mu Jm^{-2}$$

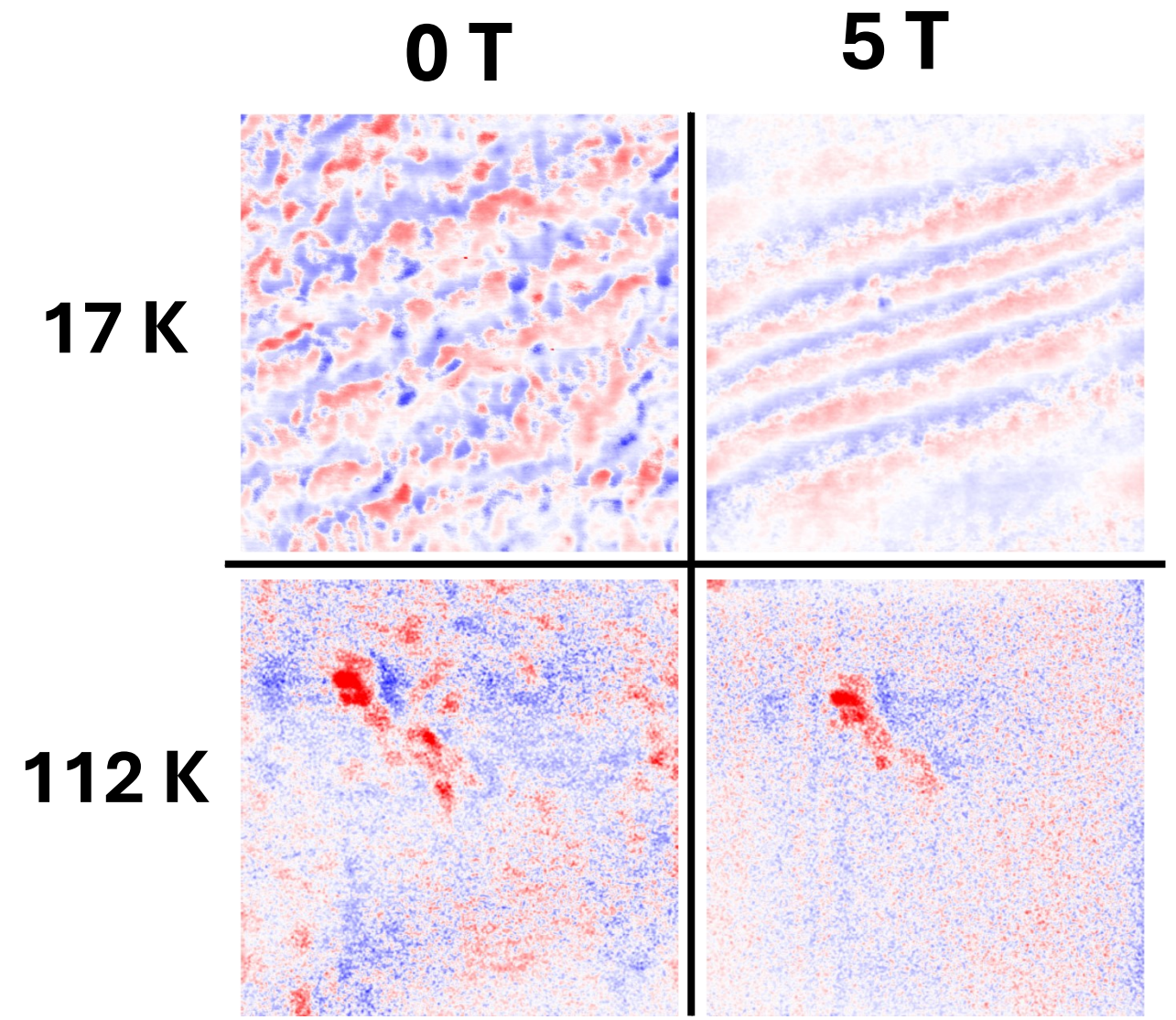
$$2\pi D/L \ll M_S B \quad !!!!!$$

B=5 T T= 17 K

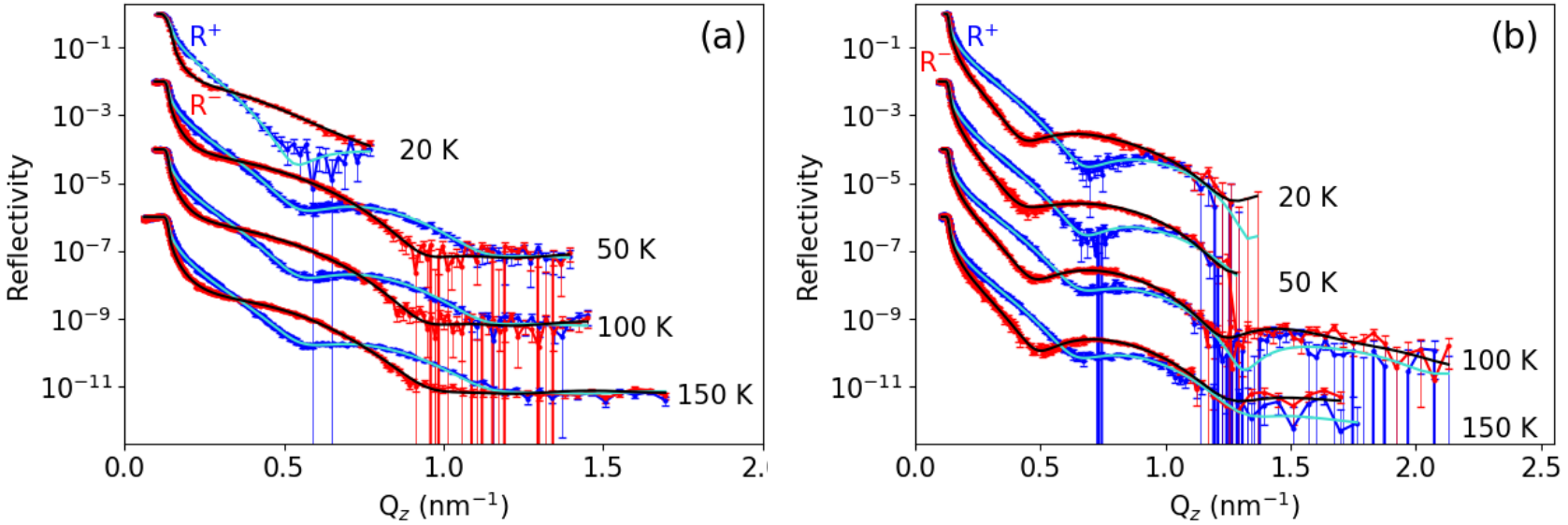


MFM study at ZFC

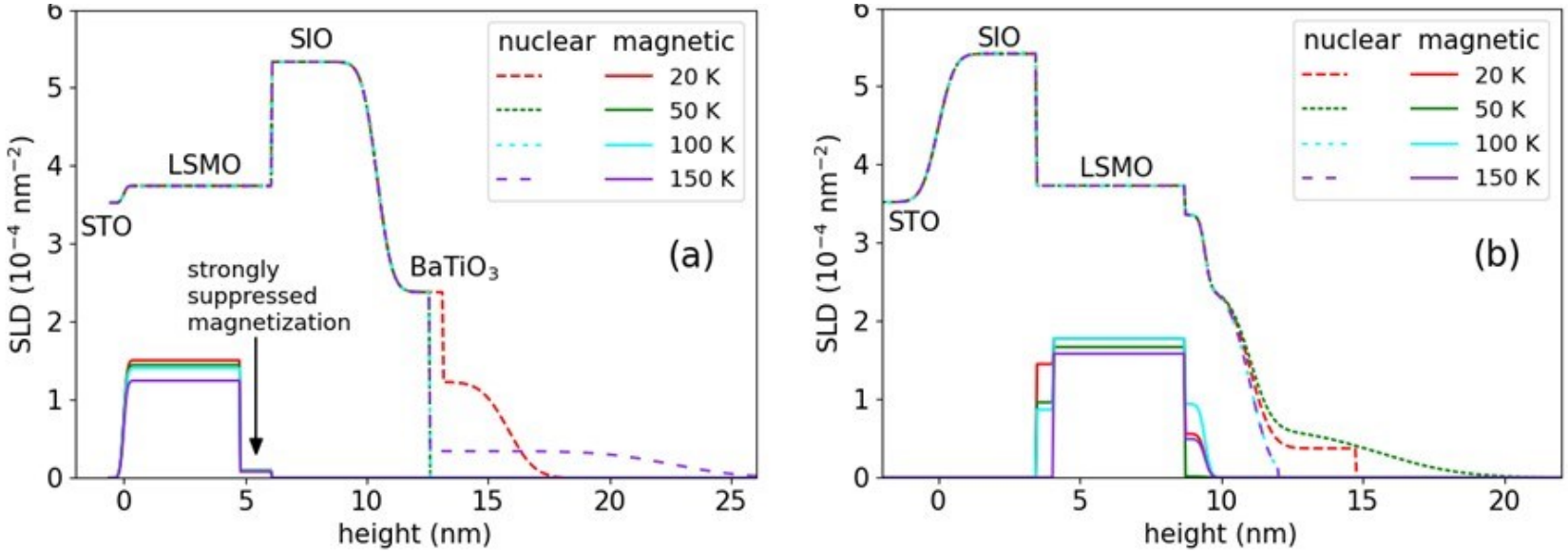
The spirals disappear at high temperature



Polarized neutron reflectometry (PNR)

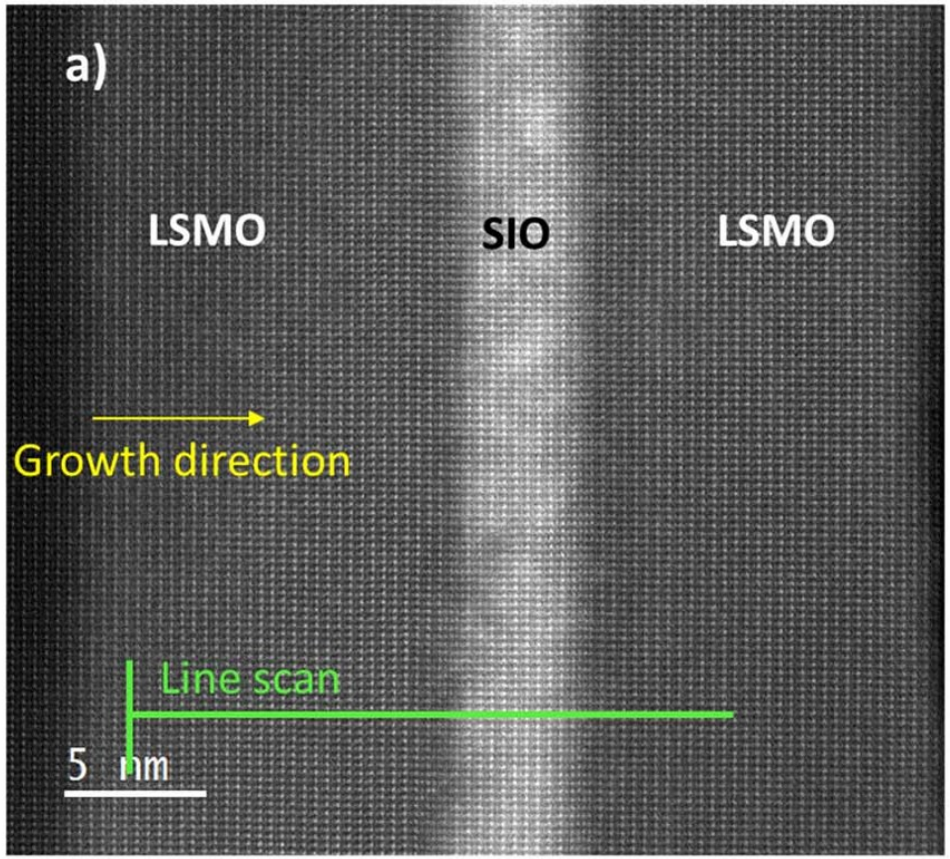


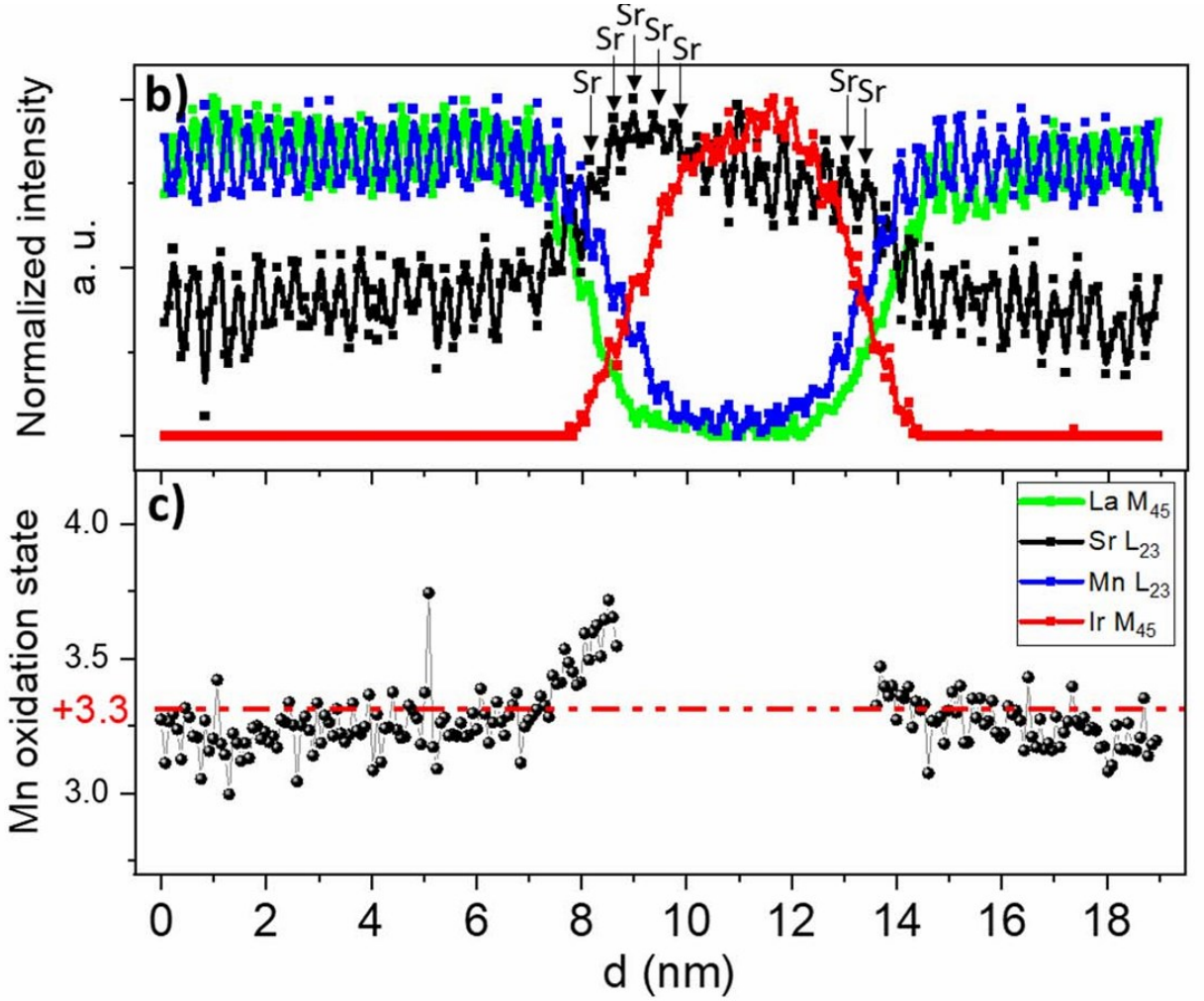
SIO
LSMO



LSMO
SIO

STEM-EELS: asymmetric interface chemistry





A. Peralta et al. Phys. R
B. ev. Materials **9**, 124402 (2025)

X-ray magnetic circular dichroism (XMCD)

LSMO (5 nm) / SIO (4 nm)

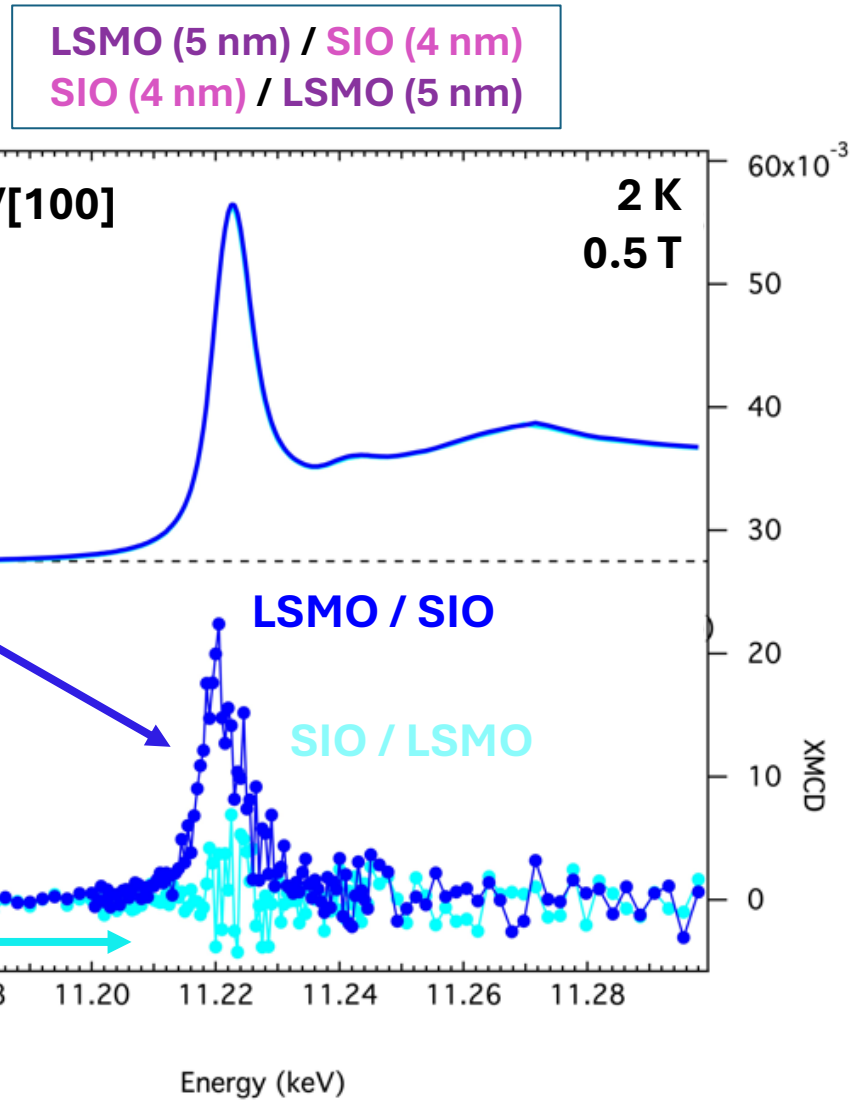
Magnetic SIO @ INTERFACE
by proximity



SIO (4 nm) / LSMO (5 nm)

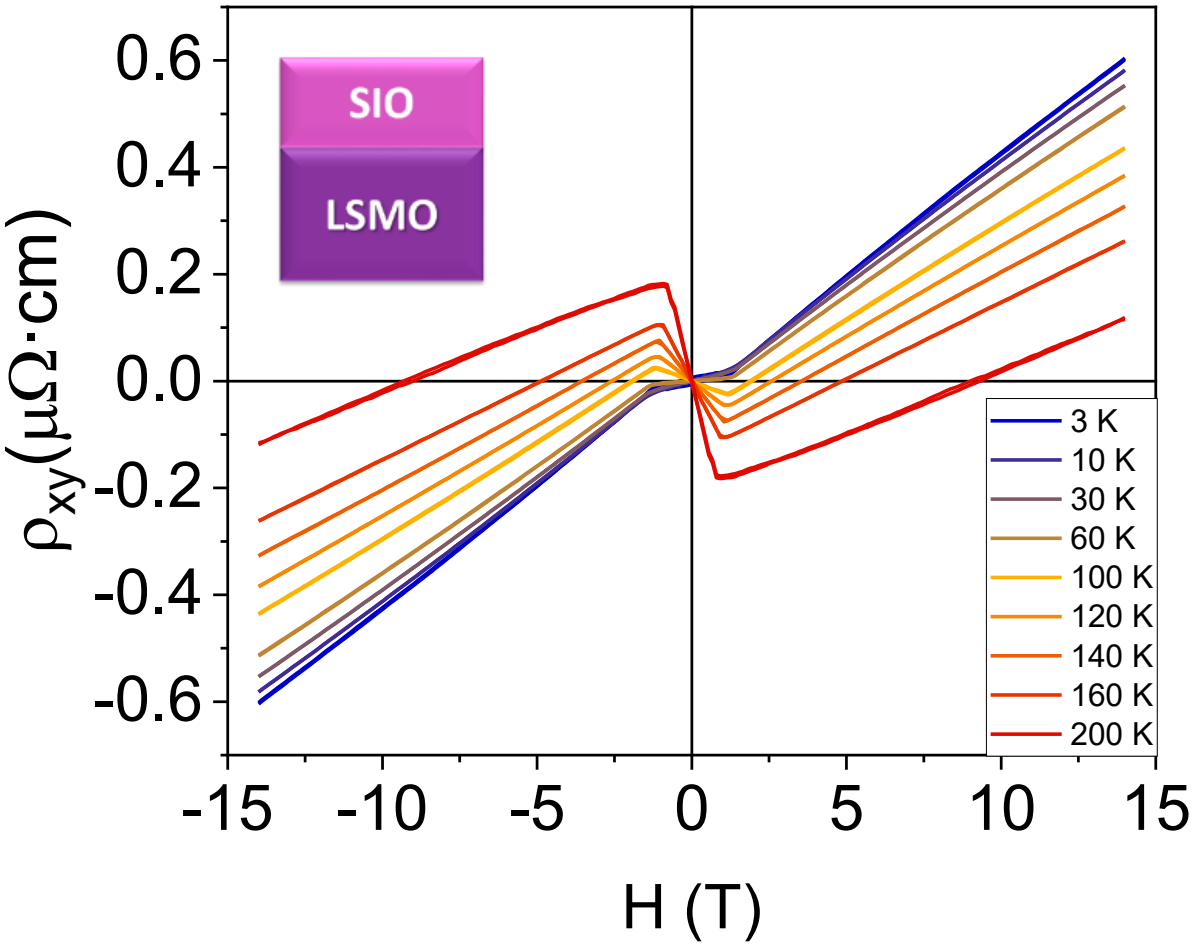
No magnetic SIO @ INTERFACE



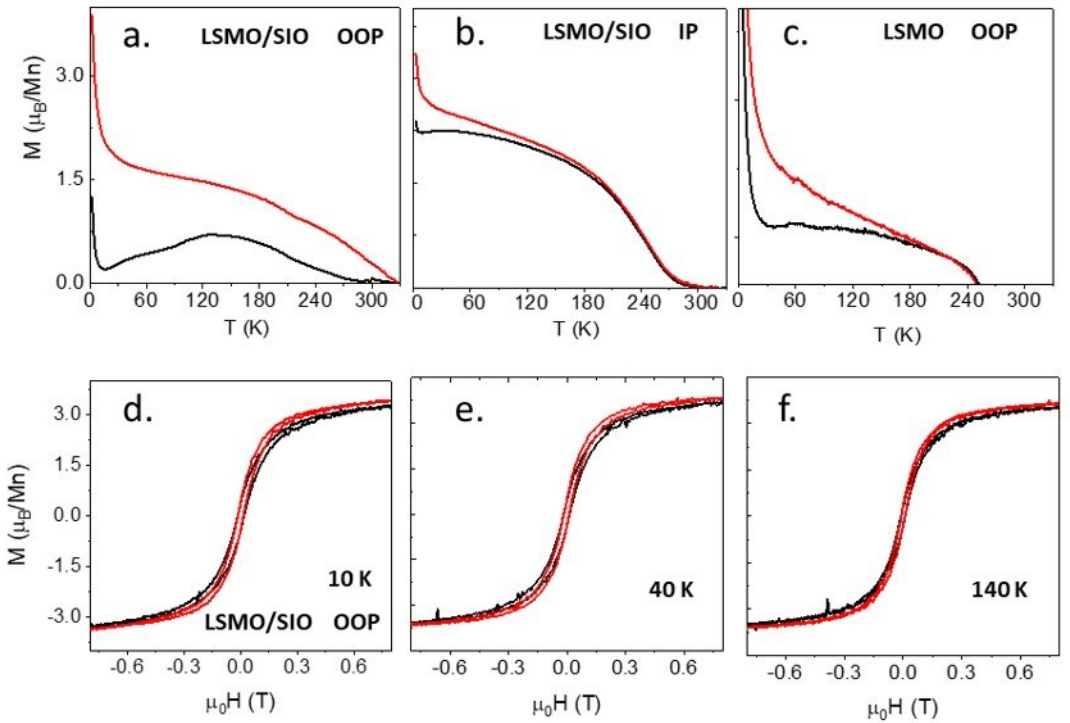


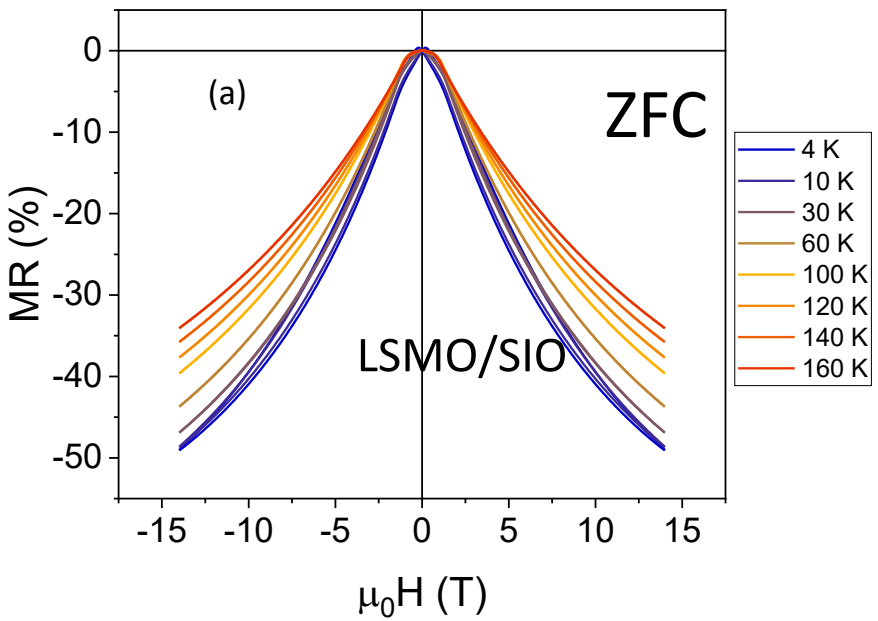
Myoung Woo Yoo et al
Nat. Comms **12**, 3283 (2021)

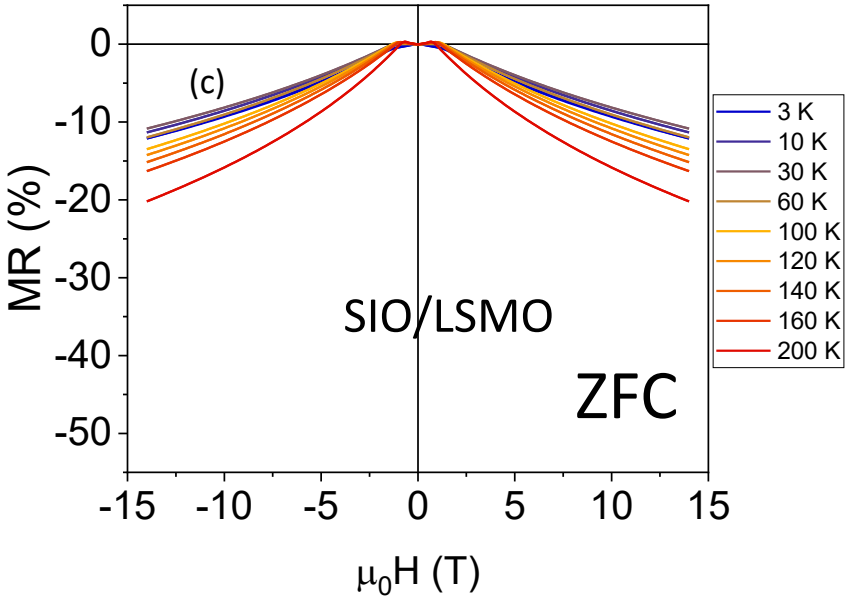
THE absent in SIO/LSMO bilayers with the reversed layer sequence

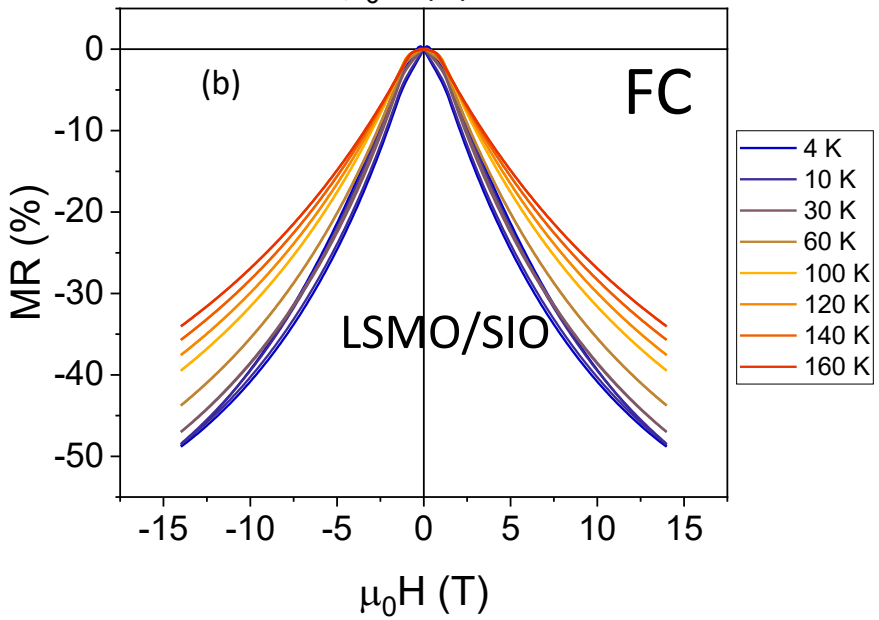


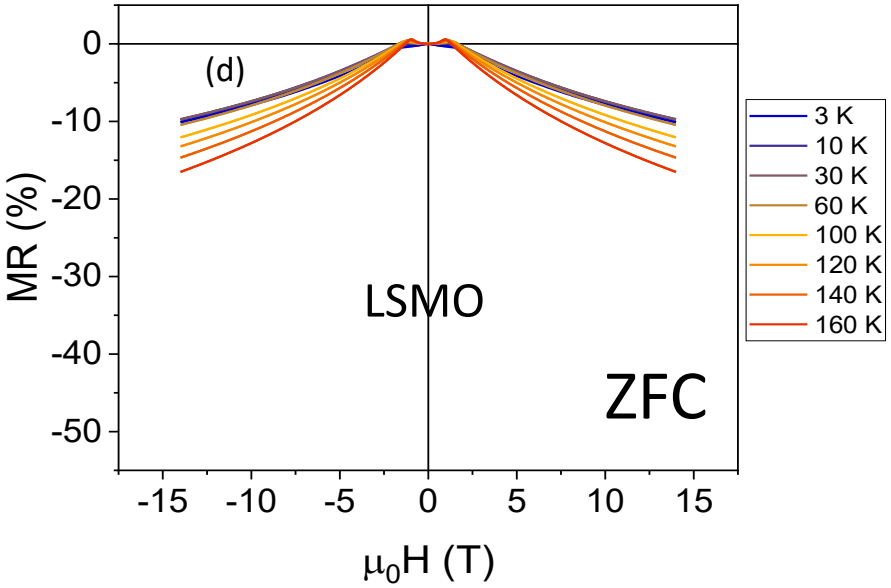
SPIRAL AND GRANULAR PHASES ARE MINORITY PHASES

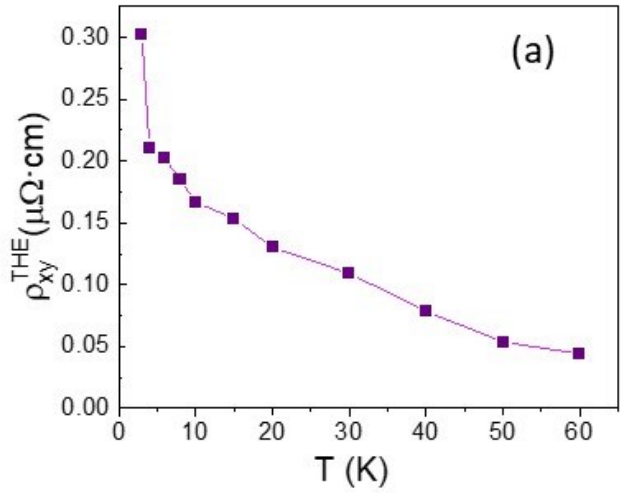


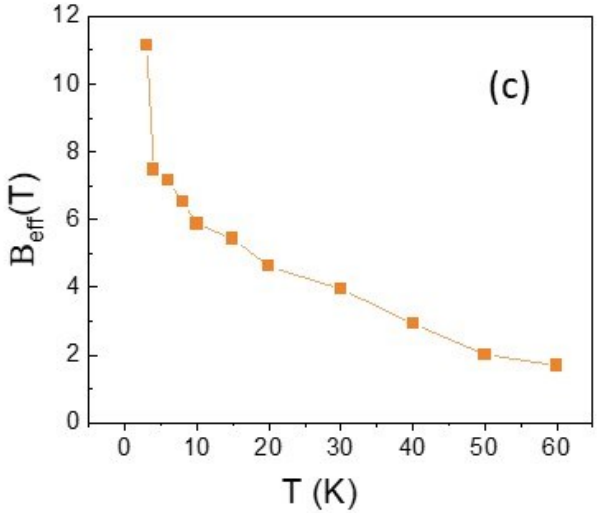

(a)
ZFC
LSMO/SIO
MR (%)
μ_0H (T)
4 K
10 K
30 K
60 K
100 K
120 K
140 K
160 K

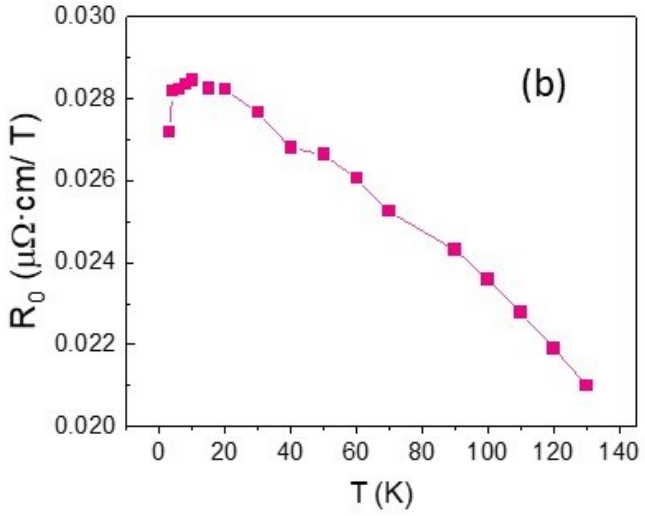

(c)
SIO/LSMO
ZFC
MR (%)
μ_0H (T)
3 K
10 K
30 K
60 K
100 K
120 K
140 K
160 K
200 K

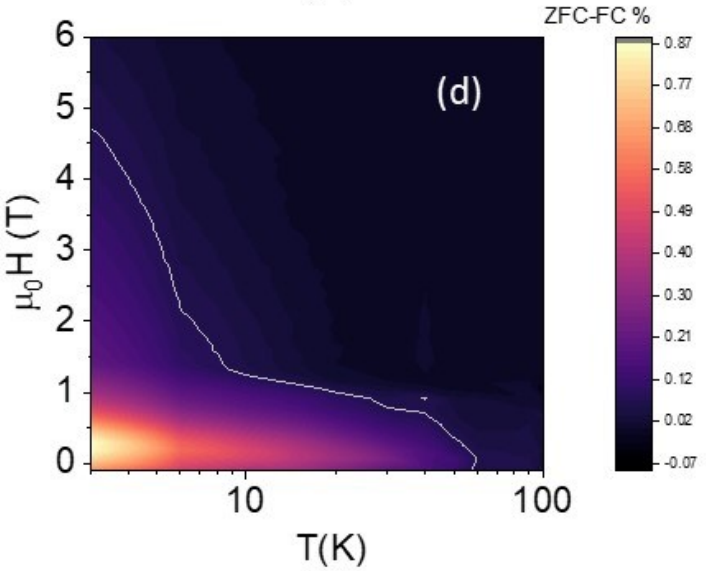

(b)
FC
LSMO/SIO
MR (%)
μ_0H (T)
4 K
10 K
30 K
60 K
100 K
120 K
140 K
160 K


(d)
LSMO
ZFC
MR (%)
μ_0H (T)
3 K
10 K
30 K
60 K
100 K
120 K
140 K
160 K







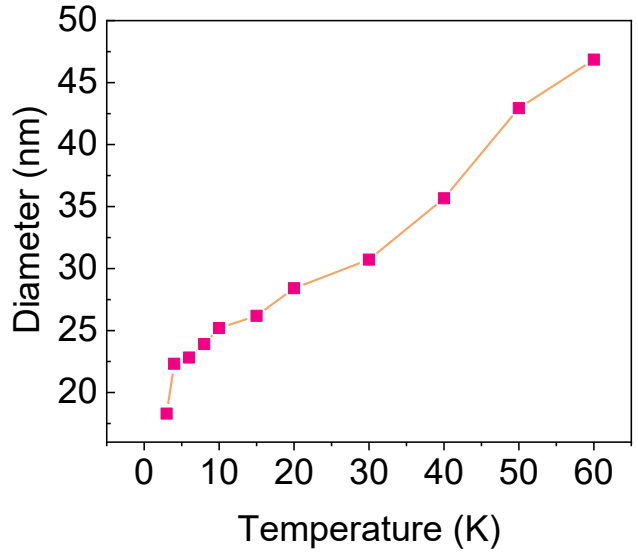


Bruno, Phys Rev Lett (2004)

Using Bruno´s formula to estimate skyrmions´ size

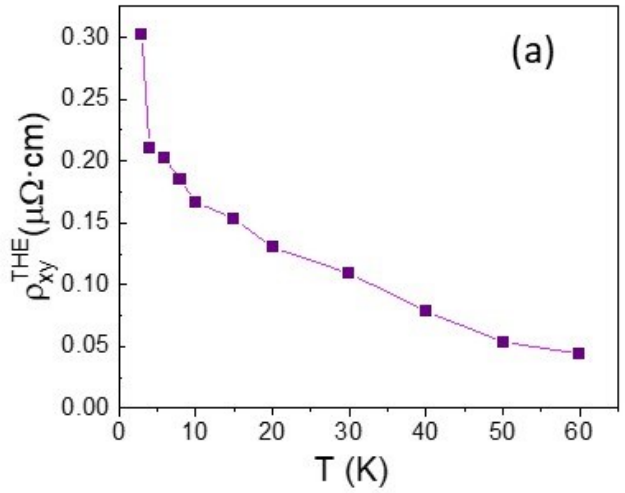
$$B_{eff} = P\, n_{eff} \Phi_0$$

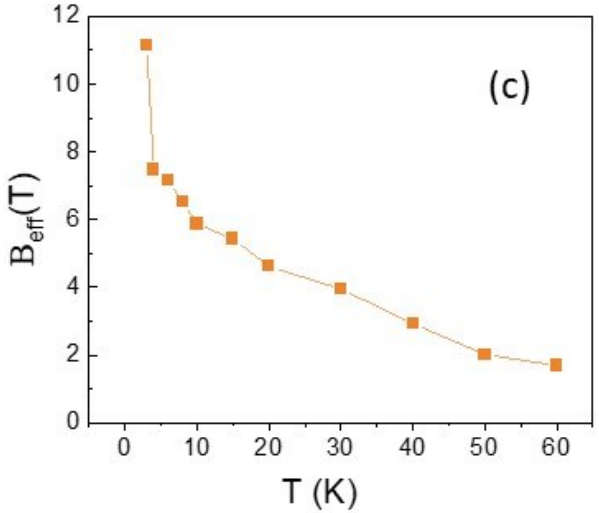
$$n_{eff} = 1/\sqrt{d}$$

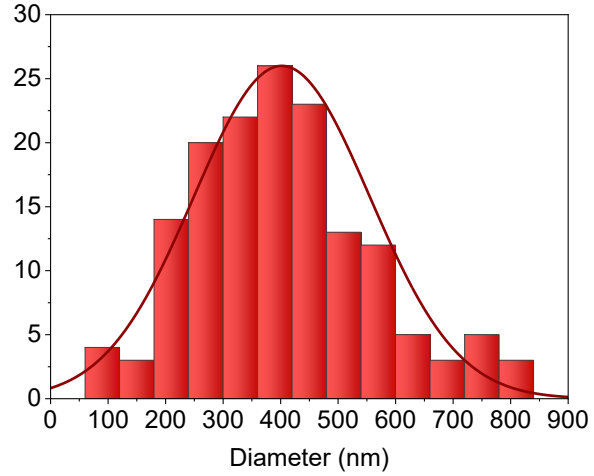


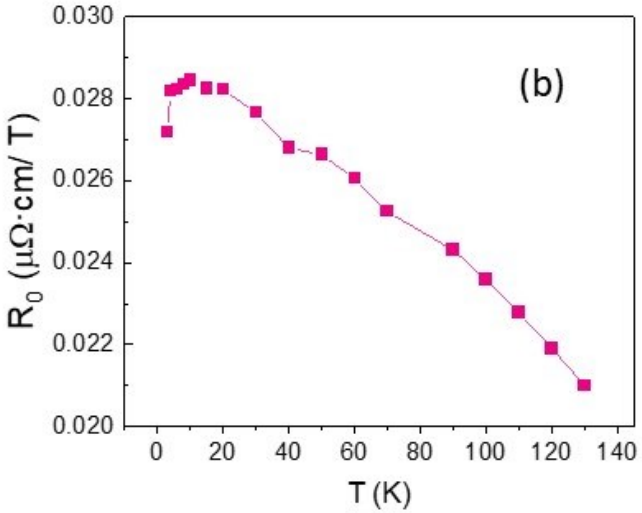
THE PHASE DIAGRAM

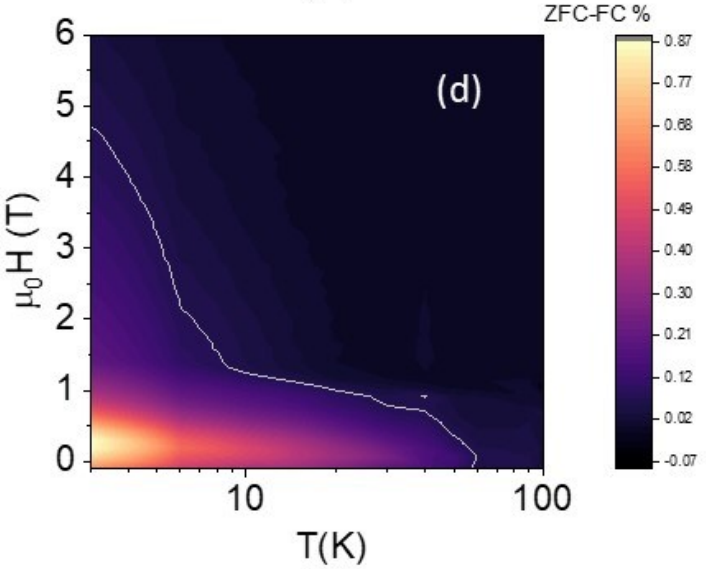
Avrg. Size ~300- 400 nm

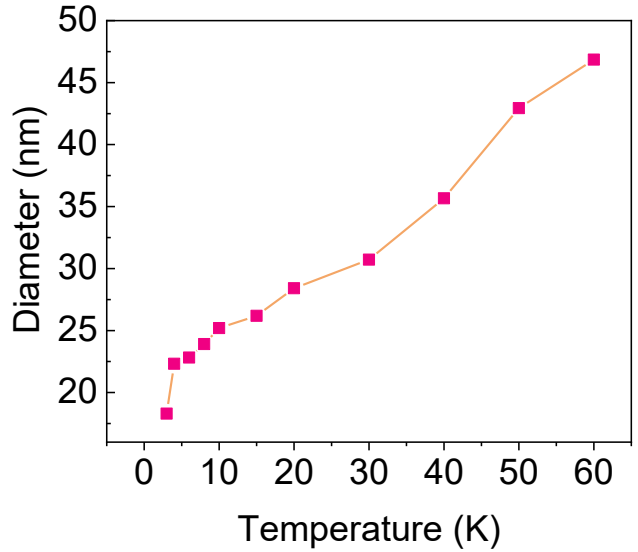




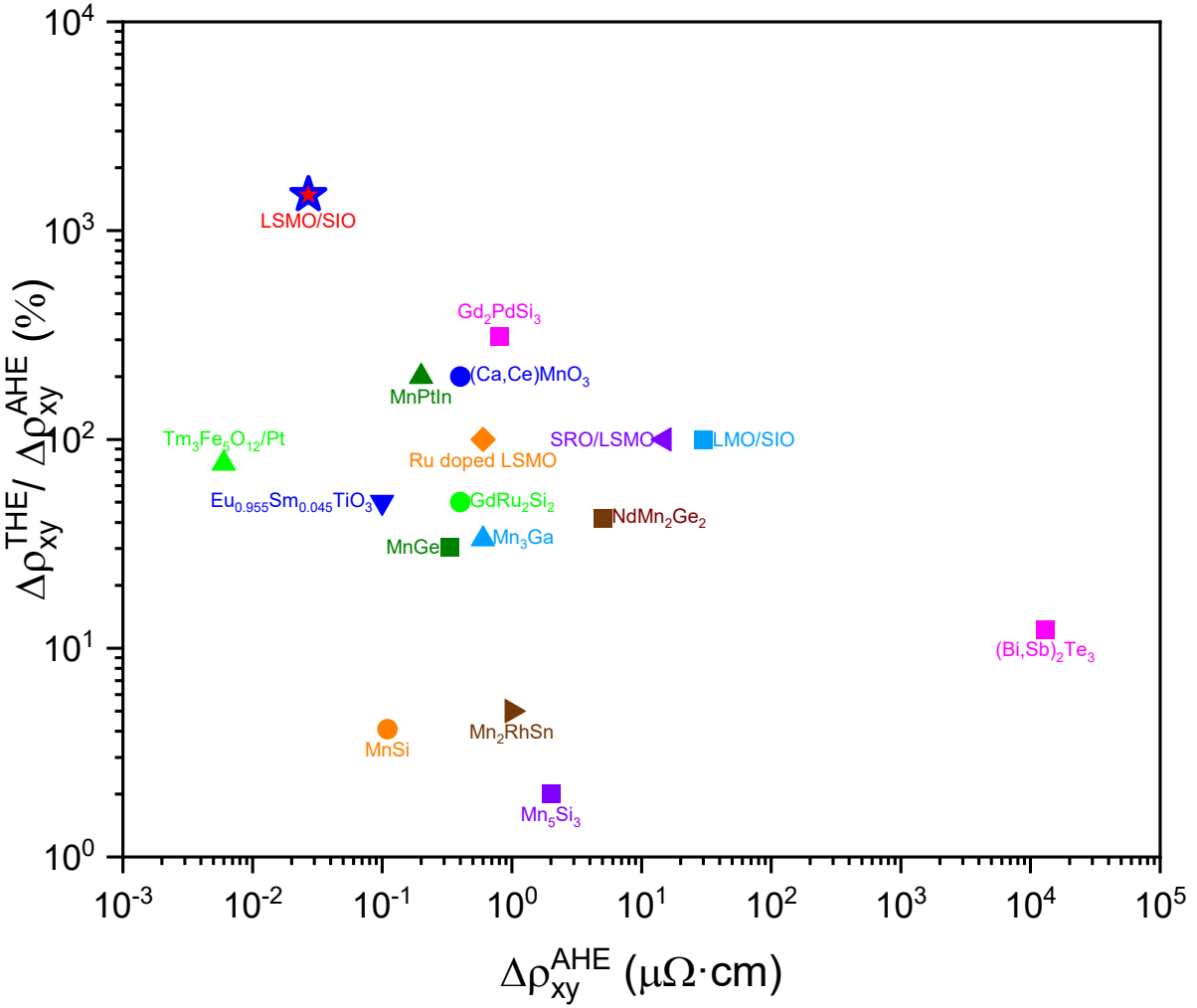








THE PHASE DIAGRAM



Conclusions

- We have shown that **chiral magnetic textures in a strongly spin-polarized oxide can act as an intrinsic source of phase bias**, providing a route to engineer φ_0 junctions.

- YBCO/LSMO/YBCO junctions are a natural platform in which spin-polarized supercurrents and chiral magnetic textures become directly coupled, with promising implications for phase-controlled superconducting spintronics.

- Using **ultrathin $La_{0.7}Sr_{0.3}MnO_3/SrIrO_3$ bilayers,** we have demonstrated a **giant THE that can be switched ON and OFF by the magnetic history, and we establish a direct one-to-one correspondence between the transport anomaly and the emergence—or disappearance—of a chiral magnetic texture at the interface.**

- Beyond providing a rare, unequivocal evidence for a pure THE, the controllable link between magnetic chirality and the giant Hall signal at oxide interfaces shows a path for engineering **reconfigurable topological responses, which could impact spintronic sensing and beyond.**