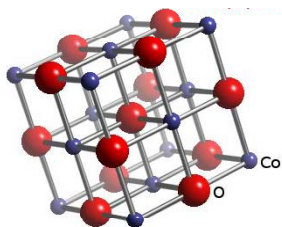
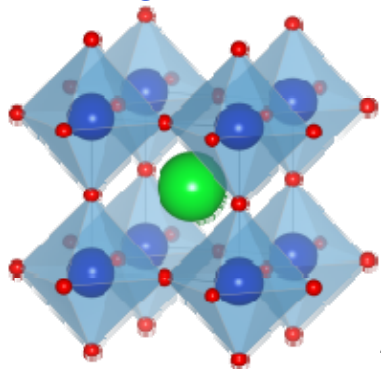


# Transition metal oxides, so simple so beautiful

CoO

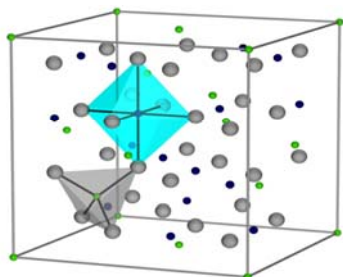


CaTiO<sub>3</sub>



A. Perovski (1792-1856)

MgAl<sub>2</sub>O<sub>4</sub>



Josep Fontcuberta

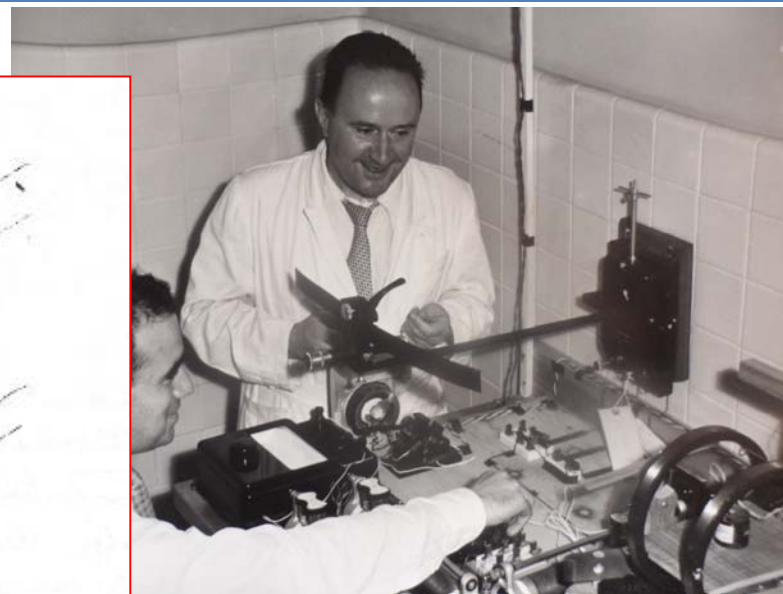
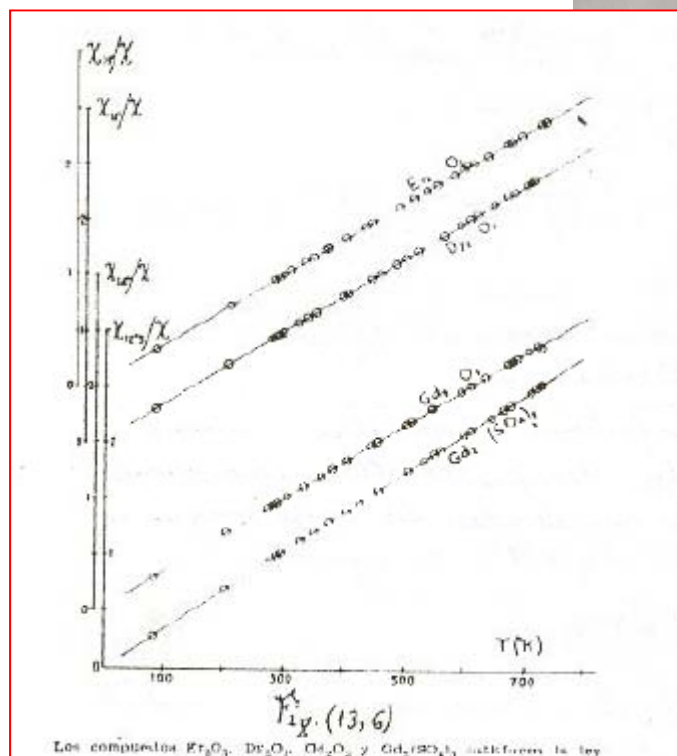
<http://www.icmab.es/mulfox/>



LABORATORY OF MULTIFUNCTIONAL THIN FILMS  
AND COMPLEX STRUCTURES

INSTITUT DE CIÈNCIA DE MATERIALS DE BARCELONA ICMAB-CSIC

# Salvador Velayos (1908- 1997)



JOURNAL OF APPLIED PHYSICS

VOLUME 40, NUMBER 3

1 MARCH 1969

## Effect of the Anisotropic Exchange and the Crystalline Field on the Magnetic Susceptibility of $\text{Eu}_2\text{O}_3$

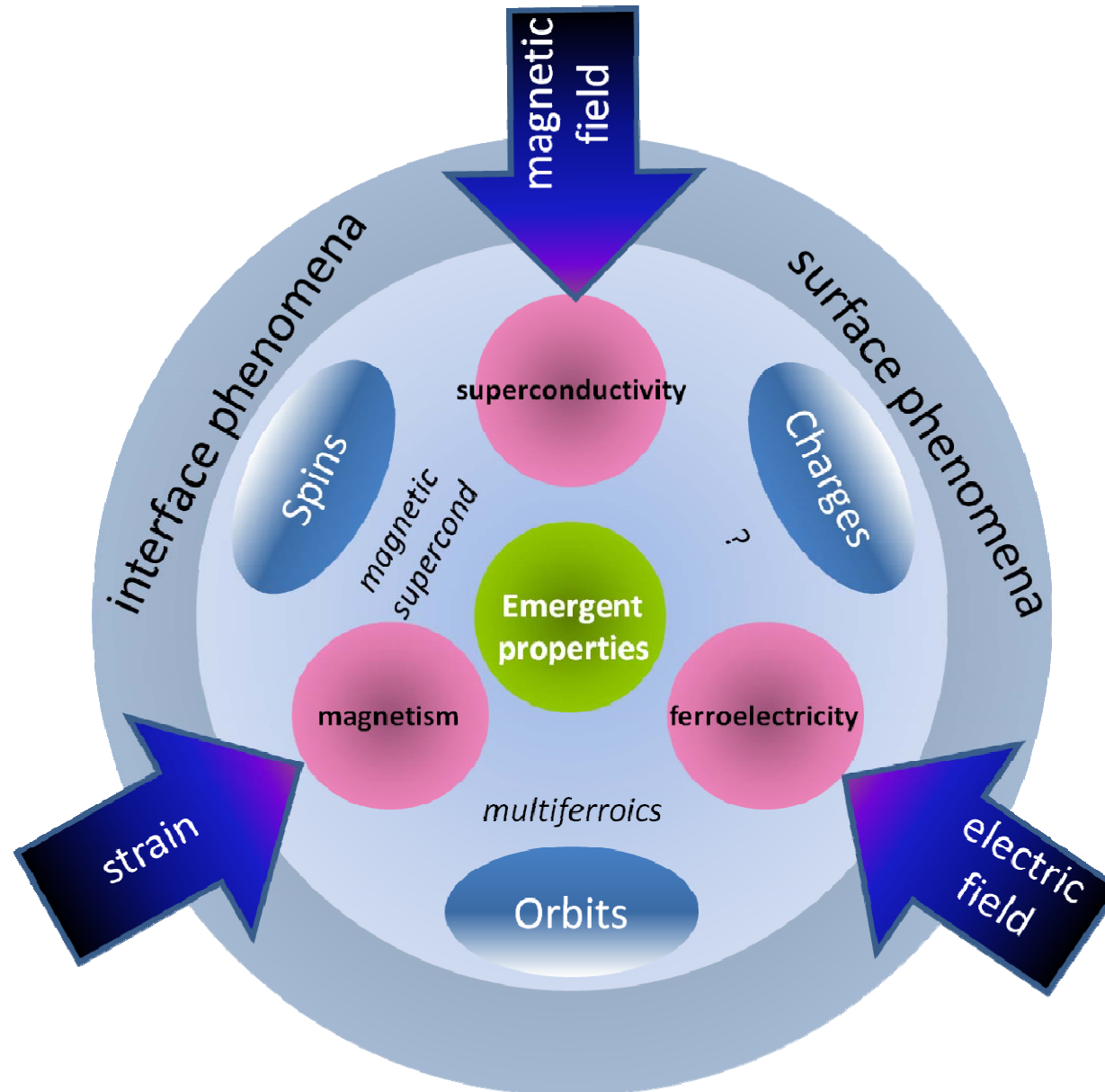
N. L. HUANG\* AND J. H. VAN VLECK

*Harvard University, Cambridge, Massachusetts 02138*

between  $\text{Gd}^{3+}$  (*S*-state) ions. Utilizing the magnetic data for  $\text{Gd}_2\text{O}_3$ ,<sup>4</sup> we find that the conventional isotropic

<sup>4</sup> S. Velayos, *Anales-Soc. Espan. Fis. Quim.* **33**, No. 5 (1935).

# Transition metal oxides, so simple, so beautiful





### Mechanism of habit change of ADP crystals by Fe<sup>3+</sup>, based on Mössbauer studies

J. Fontcuberta, R. Rodríguez

Dpto. Cristalografía y Mineralogía, Facultad de Geología, Avda. José Antonio, 585, Barcelona

J. Tejada

Dpto. de Física Atómica y Nuclear, Facultad de Física, Avda. Generalísimo s/n, Barcelona, Spa

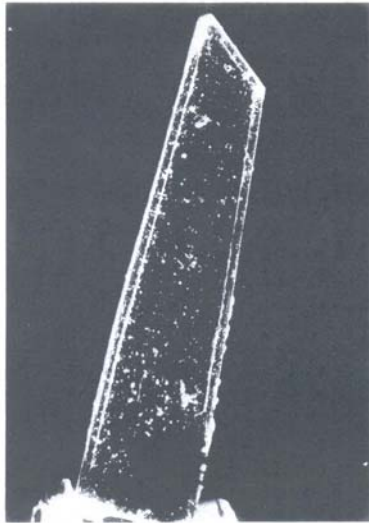
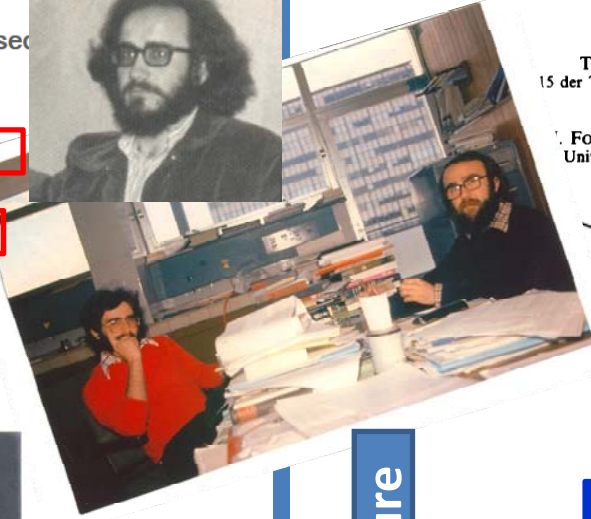
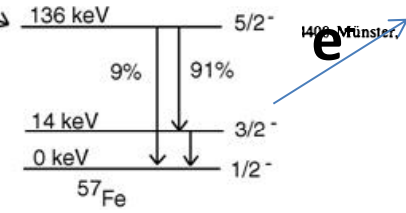


Fig. 5. Curved tapered faces.

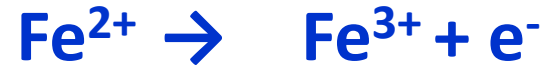
### THE INFLUENCE OF THE SEMICONDUCTOR PROPERTIES ON THE MÖSSBAUER EMISSION SPECTRA OF <sup>57</sup>Co COBALT OXIDE†

T. HARAMI, J. LOOCK and E. HUENGES  
15 der Technischen, Universität München, James-Frank-Str., 8046 Garching, Federal Republic of Germany

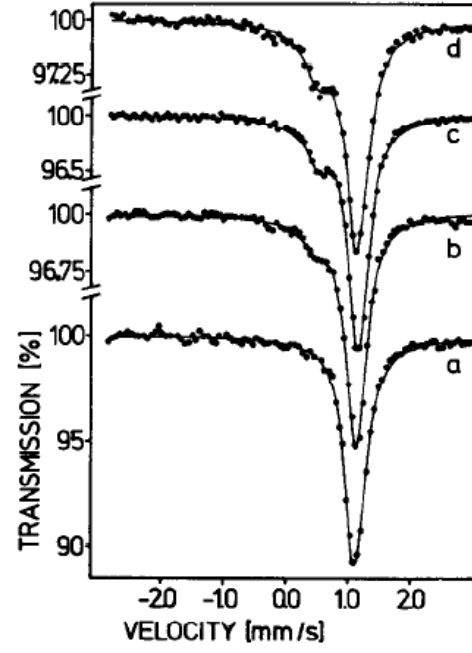
J. FONTCUBERTA, X. OBRADORS and J. TEJADA  
Universitat de Barcelona, Diagonal 645, Barcelona 28, Spain



V<sub>O</sub>

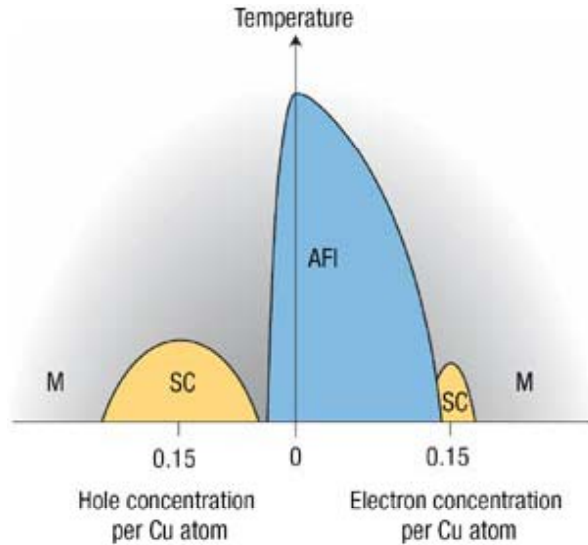


Increasing Oxygen Pressure

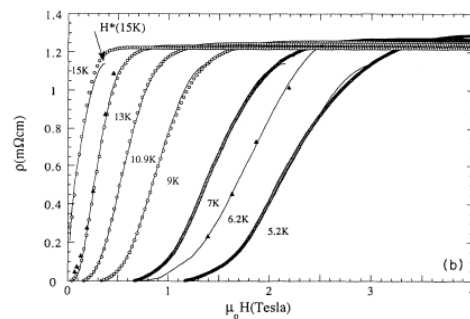
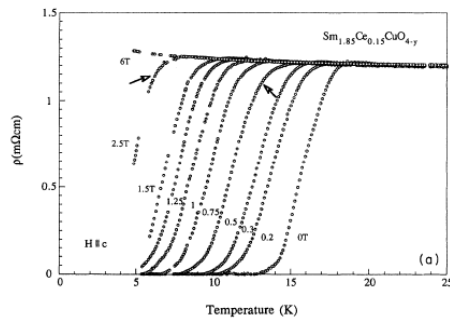


Elastic flux creep in a  $\text{Sm}_{1.85}\text{Ce}_{0.15}\text{CuO}_{4-y}$  single crystal

M. A. Crusellas, J. Fontcuberta, and S. Piñol



AFI: Antiferromagnetic insulator  
 SC: Superconductor  
 M: Metal



ac response of the vortex system in a  $\text{Pr}_{1.85}\text{Ce}_{0.15}\text{CuO}_{4-y}$  single crystal

L. Fábrega, J. Fontcuberta, and S. Piñol

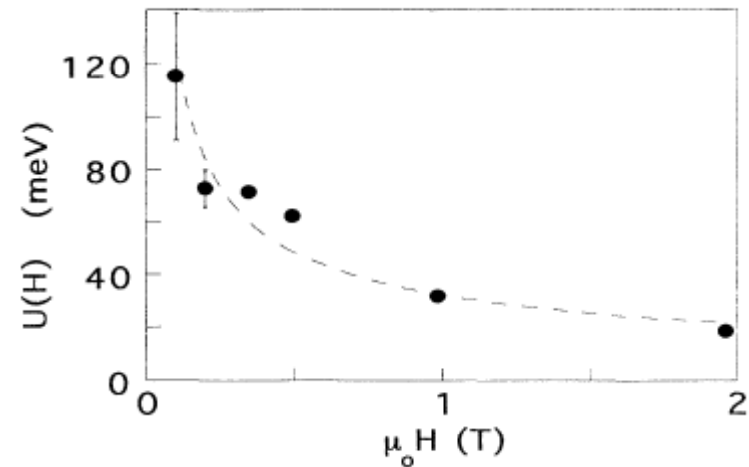
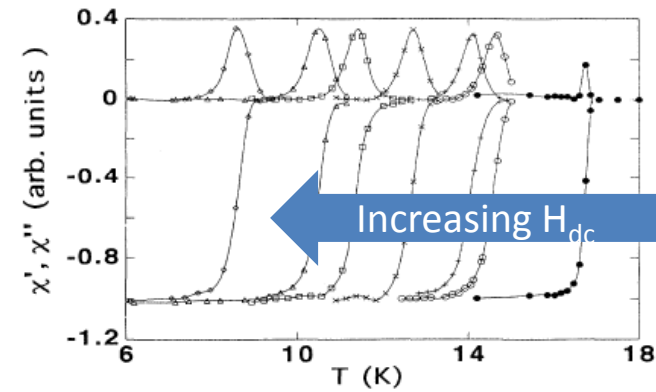
Consejo Nacional de Investigaciones (CSIC), Campus de la Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain

C. J. van der Beek\*

Kamerlingh Onnes Laboratorium der Rijksuniversiteit Leiden, P.O. Box 9506, 2300 RA Leiden, The Netherlands

P. H. Kes

Kamerlingh Onnes Laboratorium der Rijksuniversiteit Leiden, P.O. Box 9506, 2300 RA Leiden, The Netherlands



**Metallic state and the metal-insulator transition of NdNiO<sub>3</sub>**

X. Granados, J. Fontcuberta, and X. Obradors

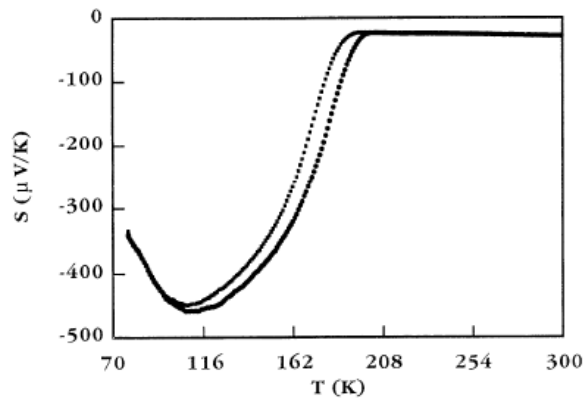
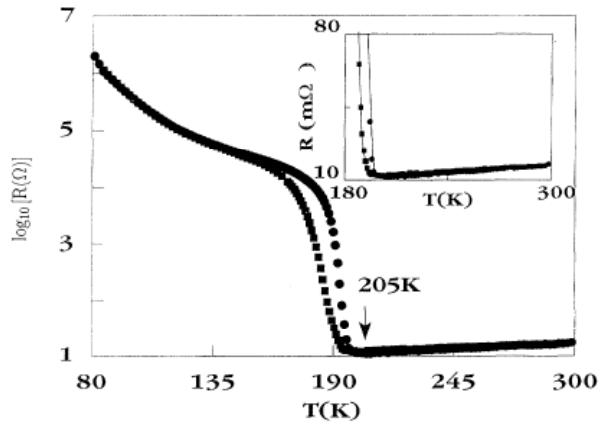
*Institut de Ciència de Materials de Barcelona, Consell Superior de Investigacions Científiques, Campus Universitat Autònoma de Barcelona, 08193 Bellaterra, Spain*

Ll. Mañosa

*Departament d'Estructura i Constituents de la Matèria, Facultat de Física de la Universitat de Barcelona, Diagonal 647, 08028 Barcelona, Spain*

J. B. Torrance

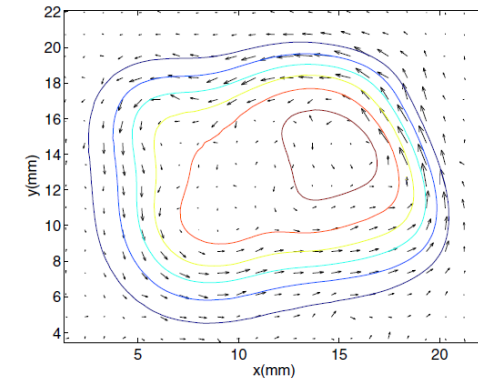
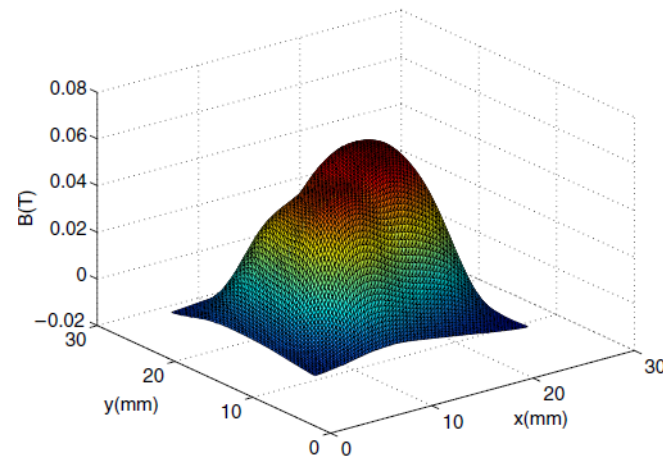
*IBM Research Division, Almaden Research Center, 650 Harry Road, San Jose, California 95120-6099*



**A new method of computation of current distribution maps in bulk high-temperature superconductors: analysis and validation**

M Carrera<sup>1</sup>, J Amorós<sup>2</sup>, X Obradors<sup>3</sup> and J Fontcuberta<sup>3</sup>

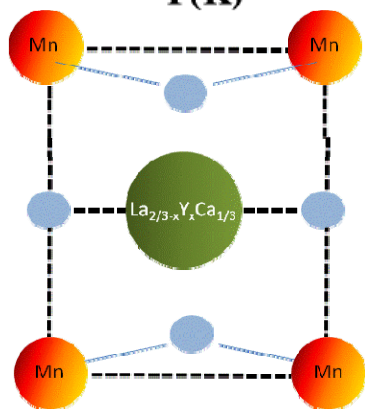
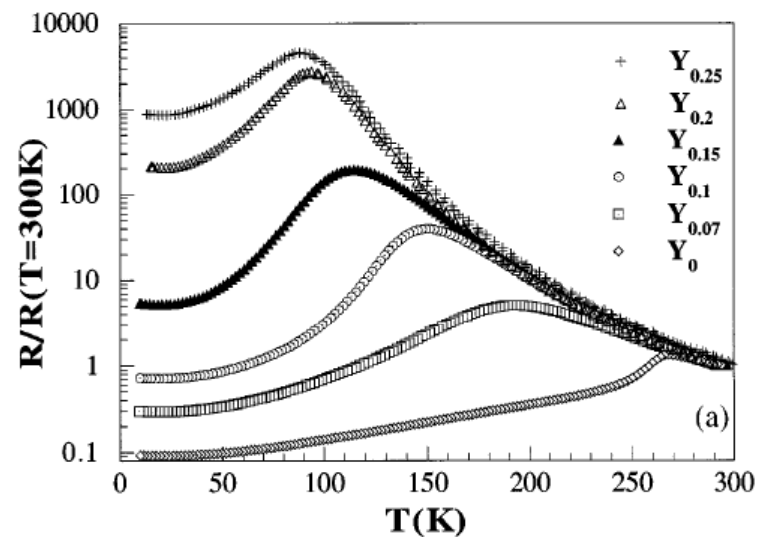
**Melt textured YBa<sub>2</sub>Cu<sub>3</sub>O<sub>7</sub>**



### Colossal Magnetoresistance of Ferromagnetic Manganites: Structural Tuning and Mechanisms

J. Fontcuberta, B. Martínez, A. Seffar, S. Piñol, J. L. García-Muñoz, and X. Obradors

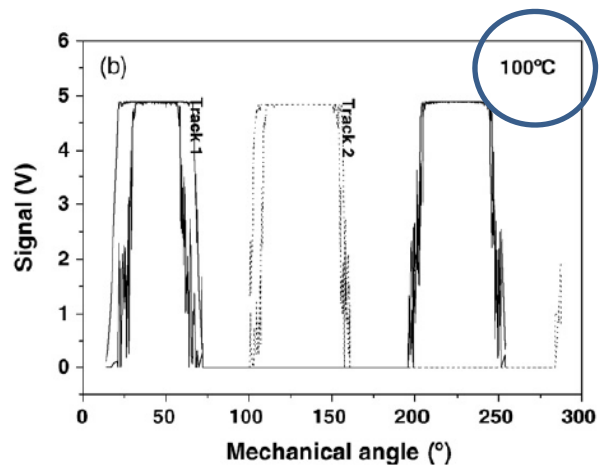
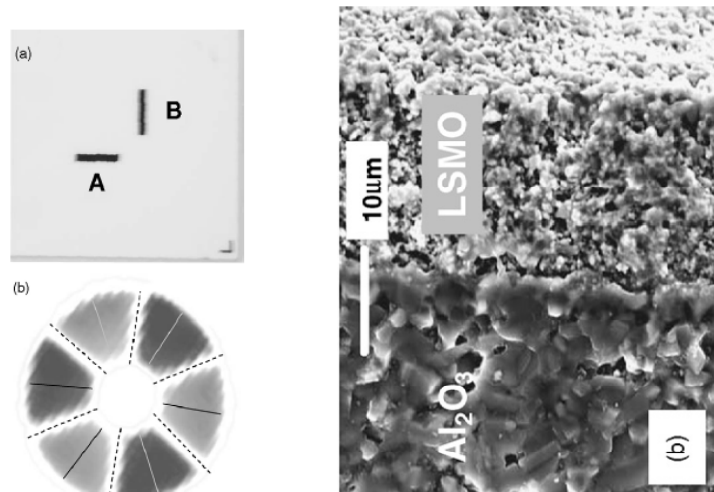
## $\text{La}_{2/3-x}\text{Y}_x\text{Ca}_{1/3}\text{MnO}_3$ ceramics



## On–off magnetoresistive sensor based on screen-printed $\text{La}_{2/3}\text{Sr}_{1/3}\text{MnO}_3$ manganite

D. Rubi<sup>a,\*</sup>, J. Fontcuberta<sup>a</sup>, M. Lacaba<sup>b</sup>, A.M. González<sup>b</sup>, J. Baztán<sup>b</sup>,  
A. Calleja<sup>c</sup>, L. Aragonés<sup>c</sup>, X.G. Capdevila<sup>d</sup>, M. Segarra<sup>d</sup>

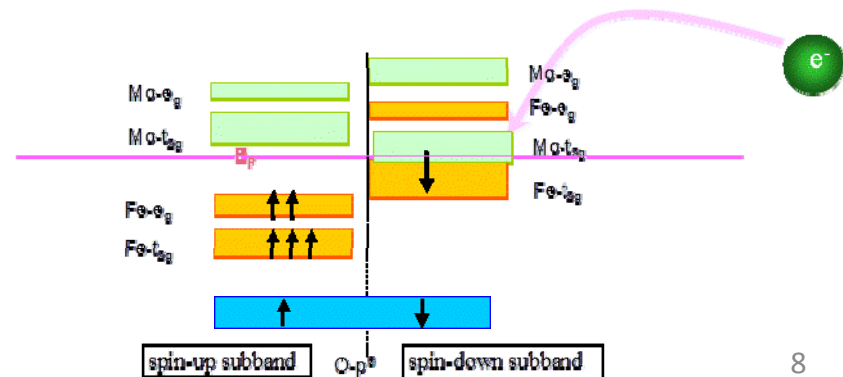
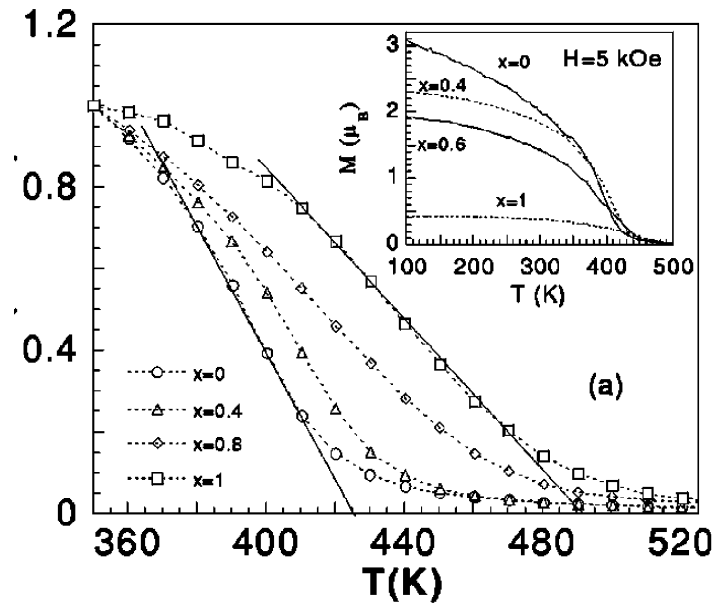
### $\text{La}_{2/3}\text{Sr}_{1/3}\text{MnO}_3$ Screen-printed films



## Raising the Curie temperature in $\text{Sr}_2\text{FeMoO}_6$ double perovskites by electron doping

J. Navarro, C. Frontera, L.I. Balcells, B. Martínez, and J. Fontcuberta\*

### $\text{Sr}_{2-x}\text{L}_x\text{FeMoO}_6$ ( $\text{L}^{3+}$ = Lanthanide) ceramics





# Home-made rf-sputtering system for thin film growth at ICMAB (2000)



M. Bibes, N. Dix, G. Herranz, LL. Balcells

## Nanoscale Multiphase Separation at $\text{La}_{2/3}\text{Ca}_{1/3}\text{MnO}_3/\text{SrTiO}_3$ Interfaces

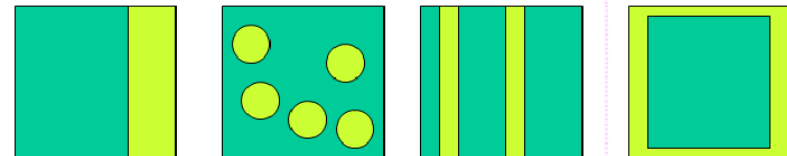
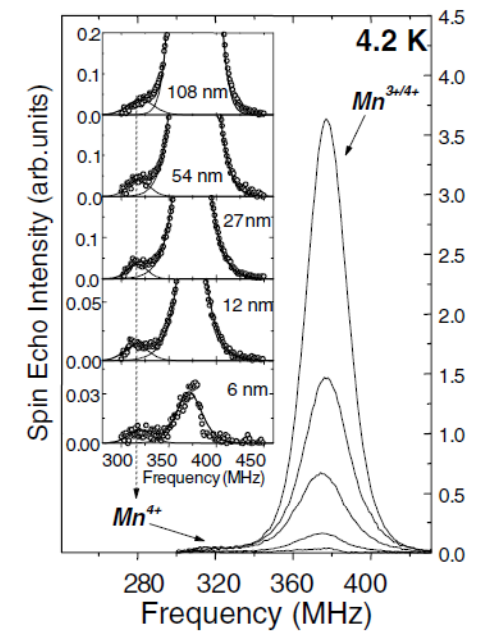
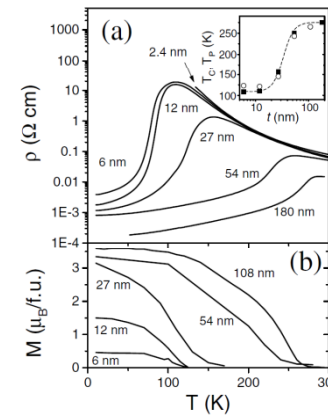
M. Bibes,\* LL. Balcells, S. Valencia, and J. Fontcuberta

Institut de Ciència de Materials de Barcelona, CSIC, Campus de la UAB, E-08193 Bellaterra, Catalunya, Spain

M. Wojcik, E. Jedryka, and S. Nadolski

Institute of Physics, Polish Academy of Sciences, Al. Lotników 32/46, 02-668 Warszawa, Poland

## $\text{La}_{2/3}\text{Ca}_{1/3}\text{MnO}_3$ thin films



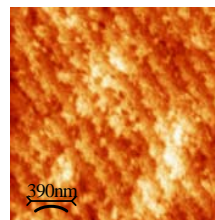
*electronic separation*

*chemical separation*

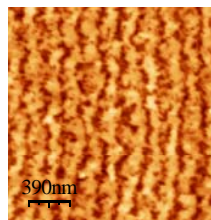
# Growth mechanism of epitaxial thin films

Florencio Sánchez & M. Varela

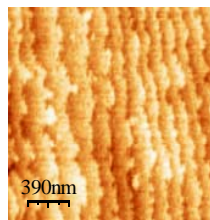
Dept. Física Aplicada Universitat de Barcelona



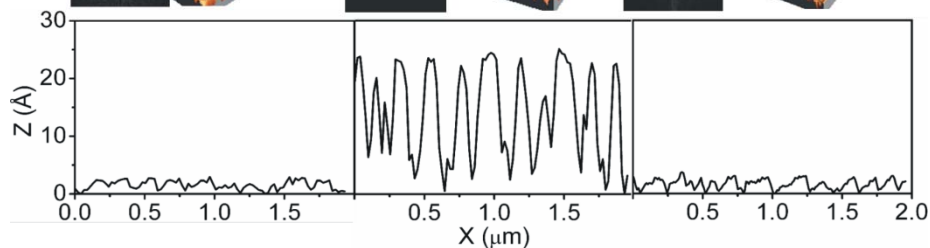
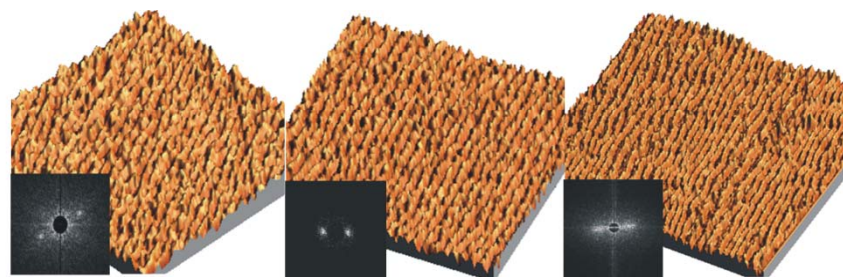
STO subst.



SRO 4 nm



SRO 160 nm



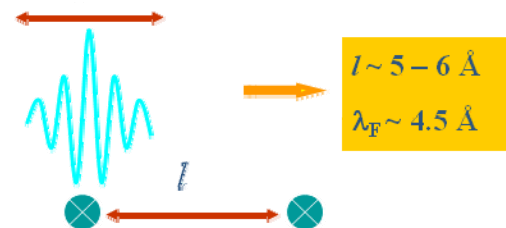
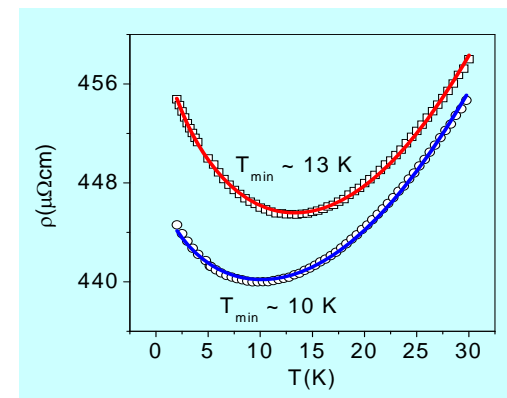
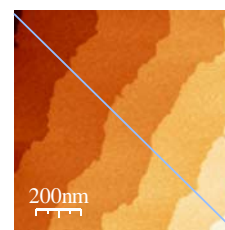
## Enhanced electron-electron correlations in nanometric SrRuO<sub>3</sub> epitaxial films

G. Herranz,<sup>\*</sup> B. Martínez, and J. Fontcuberta

*Institut de Ciència de Materials de Barcelona, CSIC, Campus UAB, Bellaterra 08193, Catalunya, Spain*

F. Sánchez,<sup>†</sup> C. Ferrater, M. V. García-Cuenca, and M. Varela

## SrRuO<sub>3</sub> thin films (PLD - UB)



Quantum corrections must be considered in low temperature electrical transport:

**SELF-INTERFERENCE OF ELECTRON WAVE-PACKETS**

Low- temperature conductance is suppressed.

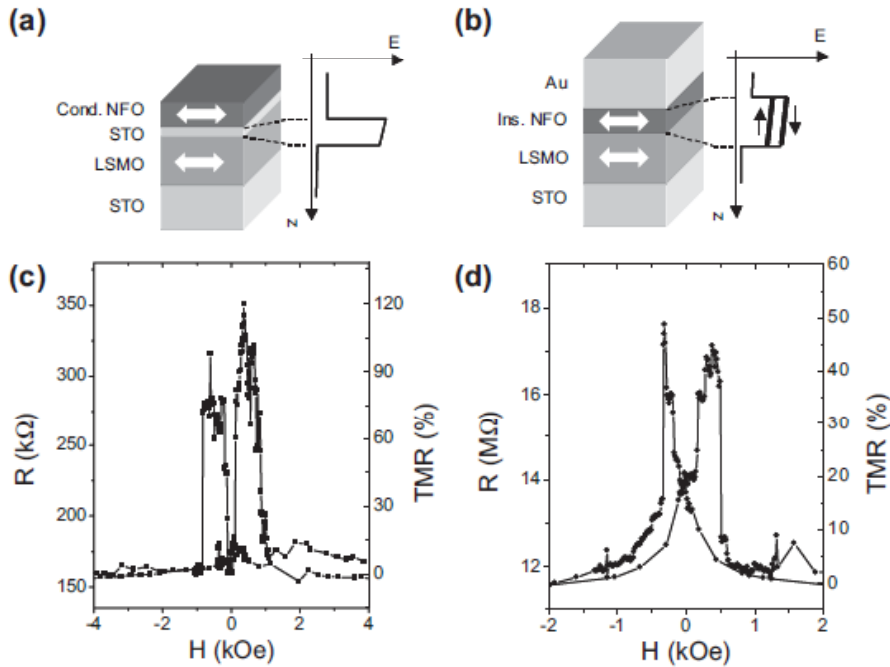
**NiFe<sub>2</sub>O<sub>4</sub>: A Versatile Spinel Material Brings New Opportunities for Spintronics\*\***

By **Ulrike Lüders**, Agnès Barthélémy\*, Manuel Bibes, Karim Bouzehouane, Stéphane Fusil, Eric Jacquet, Jean-Pierre Contour, Jean-François Bobo, Josep Fontcuberta, and Albert Fert

NiFe<sub>2</sub>O<sub>4</sub> thin films

Magnetic Tunnel Junction

Spin filter

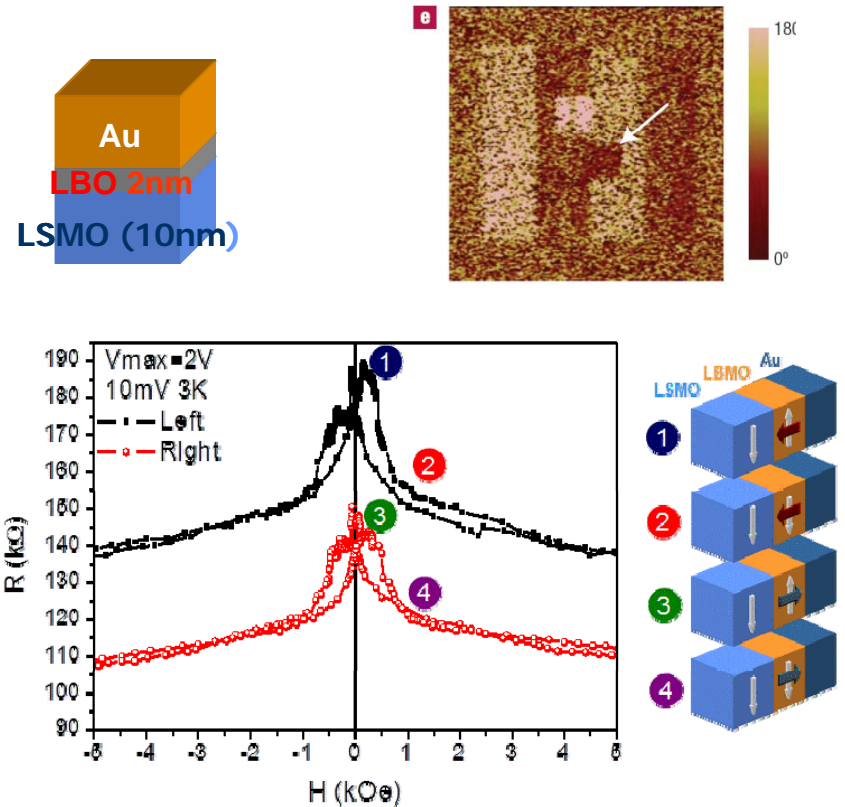


COMMUNICATIONS

Tunnel junctions with multiferroic barriers

MARTIN GAJEK<sup>1,2</sup>, MANUEL BIBES<sup>3\*</sup>, STÉPHANE FUSIL<sup>1</sup>, KARIM BOUZEHOUEANE<sup>1</sup>, JOSEP FONTCUBERTA<sup>2</sup>, AGNÈS BARTHÉLÉMY<sup>1</sup> AND ALBERT FERT<sup>1</sup>

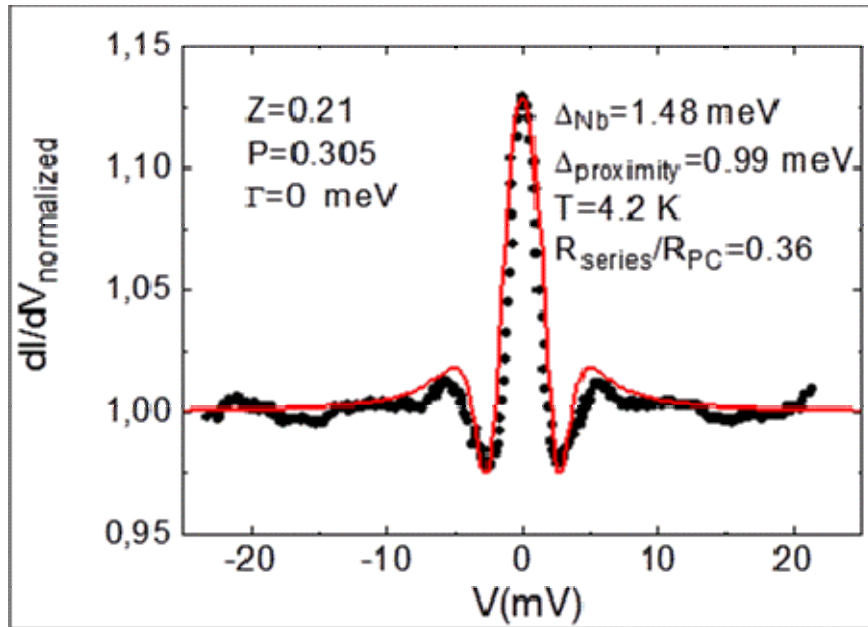
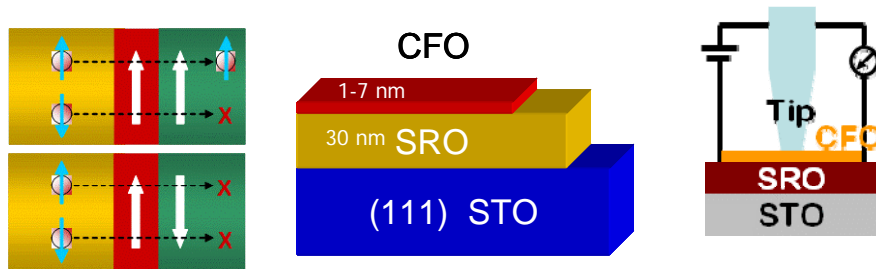
(LaSr)MnO<sub>3</sub>/BiMnO<sub>3</sub> (2nm) /Au



Four states 2 terminal device (MTJ)

Andreev reflection in ferrimagnetic  $\text{CoFe}_2\text{O}_4$  spin filters

Franco Rigato,<sup>1</sup> Samanta Piano,<sup>2,3</sup> Michael Foerster,<sup>1</sup> Filippo Giubileo,<sup>3</sup> Anna Maria Cucolo,<sup>3</sup> and Josep Fontcuberta<sup>1</sup>



Elastic and orbital effects on thickness-dependent properties of manganite thin films

I. C. Infante, F. Sánchez, and J. Fontcuberta

Institut de Ciència de Materials de Barcelona-CSIC, Campus UAB, 08193 Bellaterra, Spain

M. Wojcik and E. Jedryka

Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, 02 668 Warszawa, Poland

S. Estradé and F. Peiró

EME/CeRMAE/IN2UB, Departament d'Electrònica, Universitat de Barcelona, 08028 Barcelona, Spain

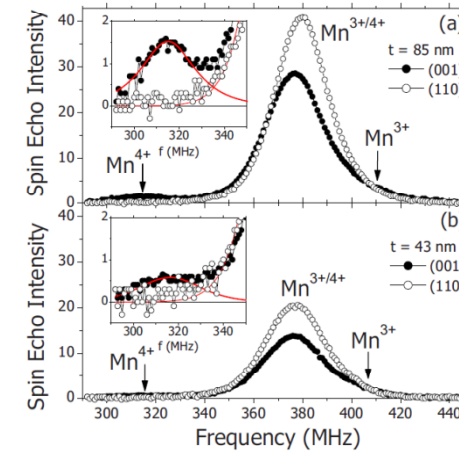
J. Arbiol

EME/CeRMAE/IN2UB, Departament d'Electrònica and TEM-MAT, Serveis Científicotècnics, Universitat de Barcelona, 08028 Barcelona, Spain

V. Laukhin

Institut de Ciència de Materials de Barcelona-CSIC, Campus UAB, 08193 Bellaterra, Spain and Institut Català d'Investigació i Estudis Avançats (ICREA), Passeig Lluís Companys 23, 08010 Barcelona, Spain

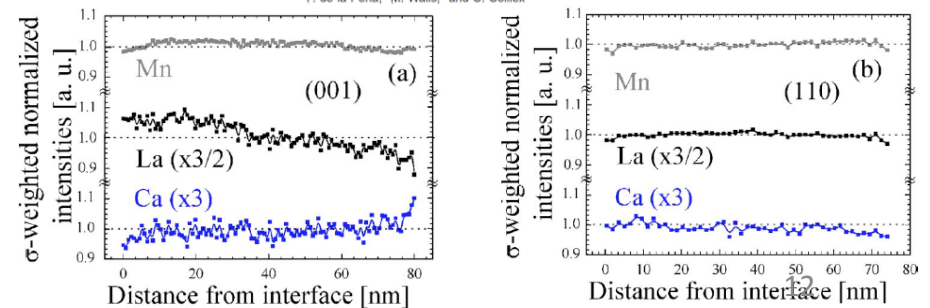
J. P. Espinós



APPLIED PHYSICS LETTERS 93, 112505 (2008)

Cationic and charge segregation in  $\text{La}_{2/3}\text{Ca}_{1/3}\text{MnO}_3$  thin films grown on (001) and (110)  $\text{SrTiO}_3$

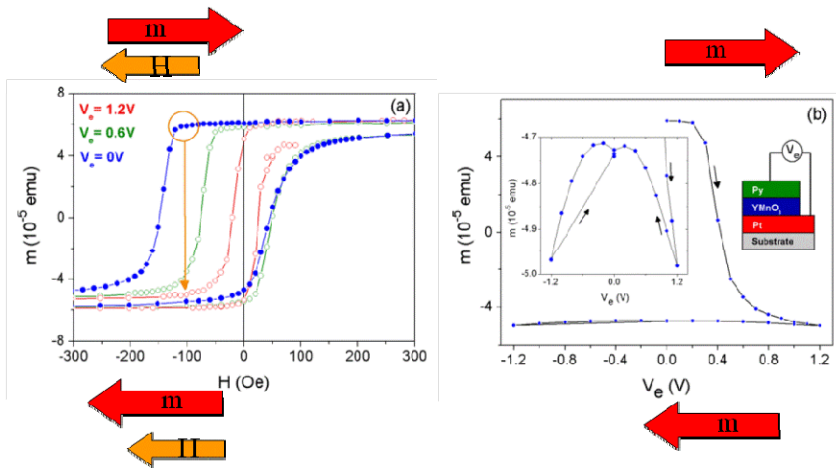
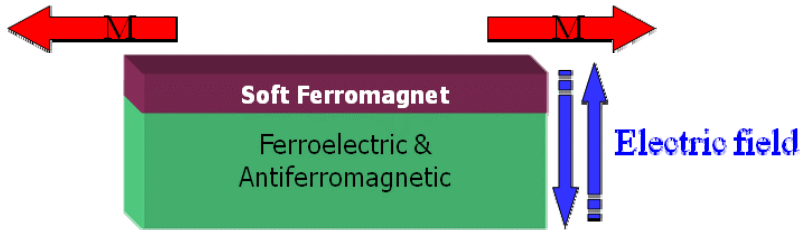
S. Estradé,<sup>1,2</sup> J. Arbiol,<sup>1</sup> F. Peiró,<sup>1</sup> I. C. Infante,<sup>2</sup> F. Sánchez,<sup>2</sup> J. Fontcuberta,<sup>2</sup> F. de la Peña,<sup>3</sup> M. Walls,<sup>3</sup> and C. Colliex<sup>3</sup>



Electric-Field Control of Exchange Bias in Multiferroic Epitaxial Heterostructures

V. Laukhin,<sup>1,2</sup> V. Skumryev,<sup>2,3</sup> X. Martí,<sup>1</sup> D. Hrabovsky,<sup>1</sup> F. Sánchez,<sup>1</sup> M. V. García-Cuenca,<sup>4</sup> C. Ferrater,<sup>4</sup> M. Varela,<sup>4</sup> U. Lüders,<sup>5</sup> J. F. Bobo,<sup>5</sup> and J. Fontcuberta<sup>1</sup>

Electric switching of Magnetization: exploiting exchange bias

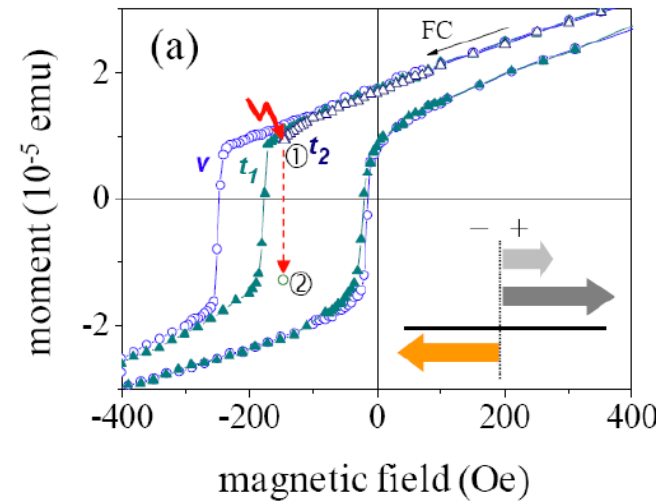
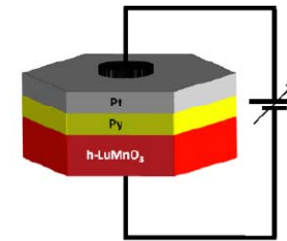


V. Laukhin et al PRL 97, 227201 (2006)

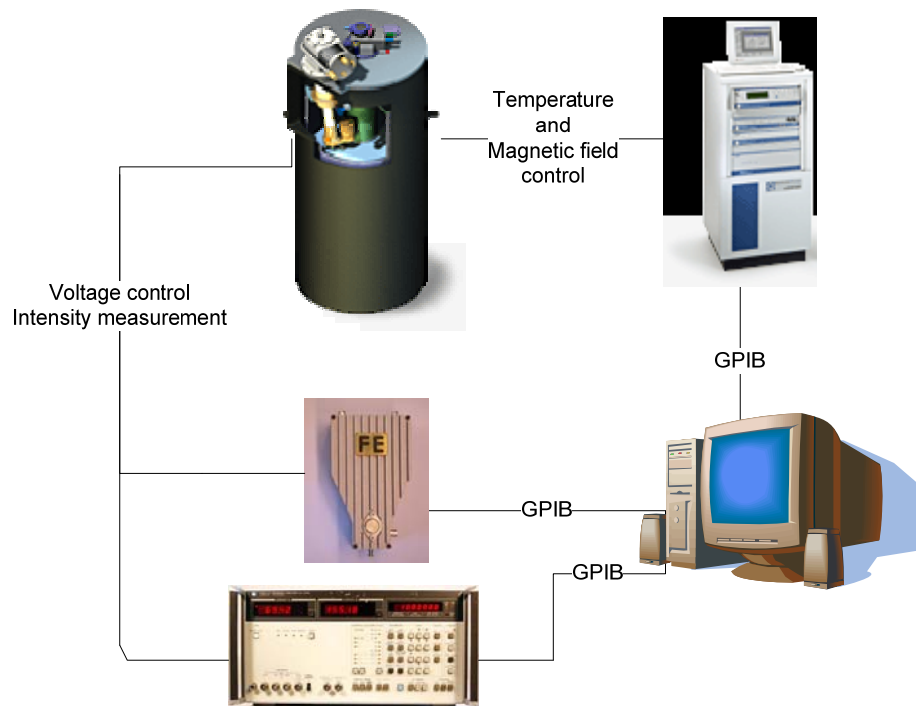
Magnetization Reversal by Electric-Field Decoupling of Magnetic and Ferroelectric Domain Walls in Multiferroic-Based Heterostructures

V. Skumryev,<sup>1,2</sup> V. Laukhin,<sup>1,3</sup> I. Fina,<sup>3</sup> X. Martí,<sup>3</sup> F. Sánchez,<sup>3</sup> M. Gospodinov,<sup>4</sup> and J. Fontcuberta<sup>3,\*</sup>

Electric switching of Magnetization: exploiting exchange bias

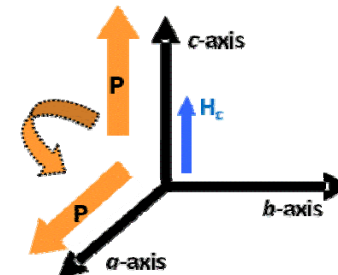
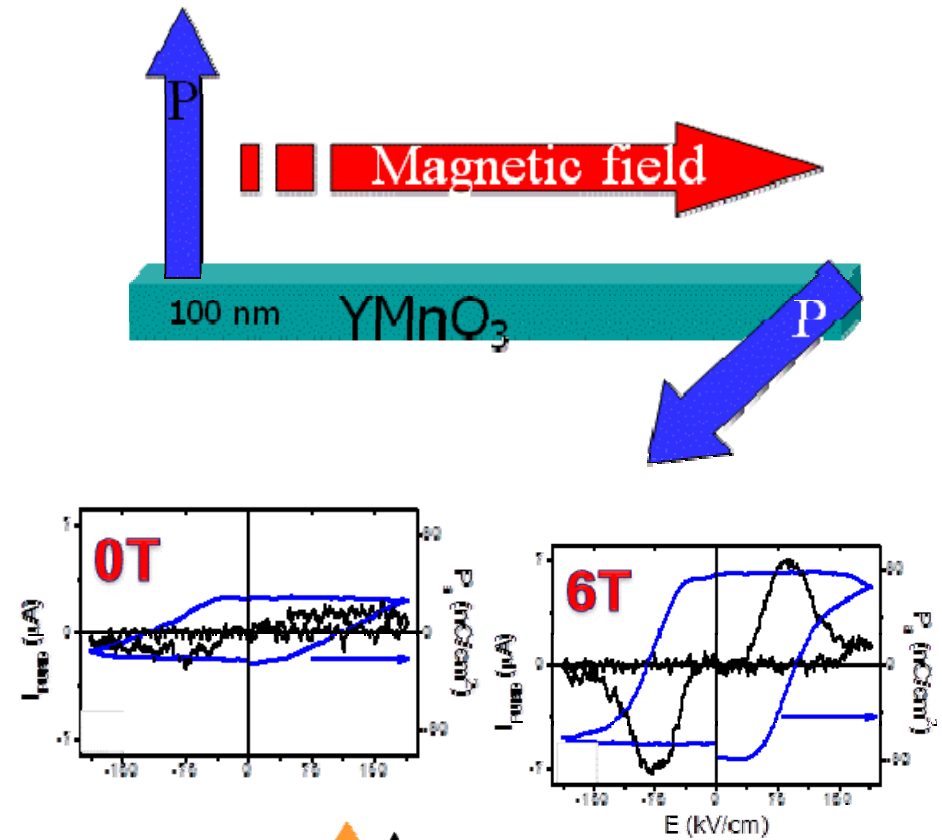


# Laboratory for dielectric characterization at ICMAB



## Chiral Domains in Cycloidal Multiferroic Thin Films: Switching and Memory Effects

J. Fina<sup>1,\*</sup>, L. Fàbrega,<sup>1</sup> X. Martí,<sup>2</sup> F. Sánchez,<sup>1</sup> and J. Fontcuberta<sup>1,†</sup>

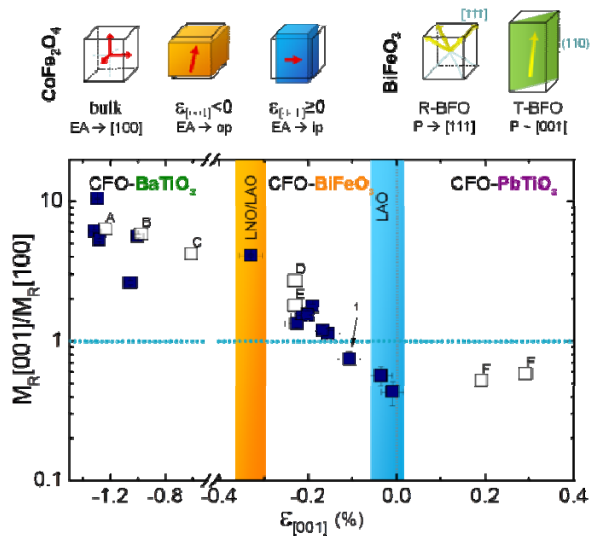
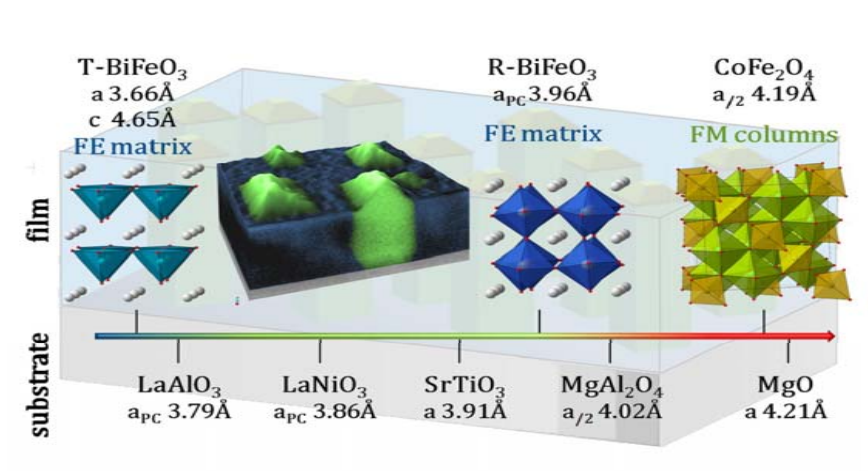


# Selectable Spontaneous Polarization Direction and Magnetic Anisotropy in BiFeO<sub>3</sub>–CoFe<sub>2</sub>O<sub>4</sub> Epitaxial Nanostructures

ARTICLE

Nico Dix,<sup>1,\*</sup> Rajaram Muralidharan,<sup>1</sup> Jose-Manuel Rebled,<sup>1,\*</sup> Sonia Estradé,<sup>1</sup> Francesca Peiró,<sup>1</sup> Manuel Varela,<sup>5</sup> Josep Fontcuberta,<sup>1</sup> and Florencio Sánchez<sup>1,\*</sup>

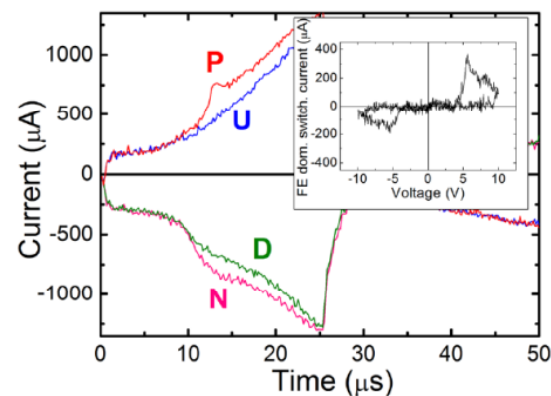
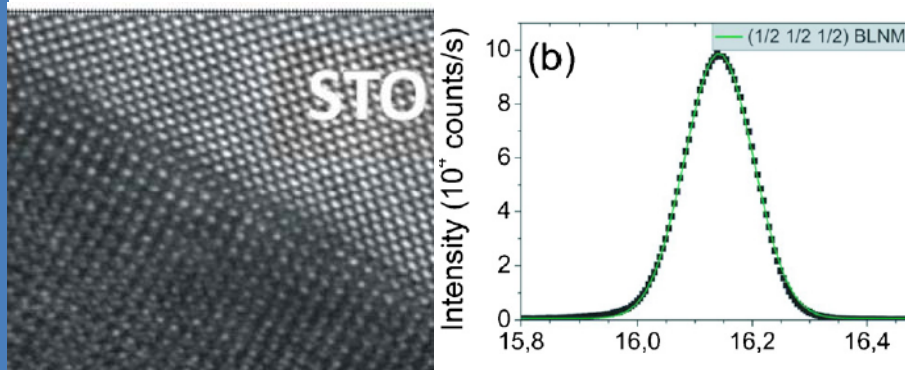
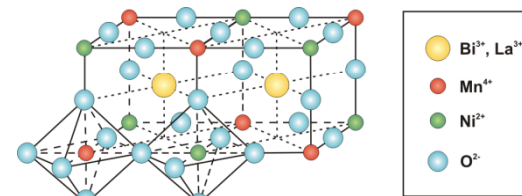
VOL. 4 ■ NO. 8 ■ 4955–4961 ■ 2010 ACS NANO | 4955



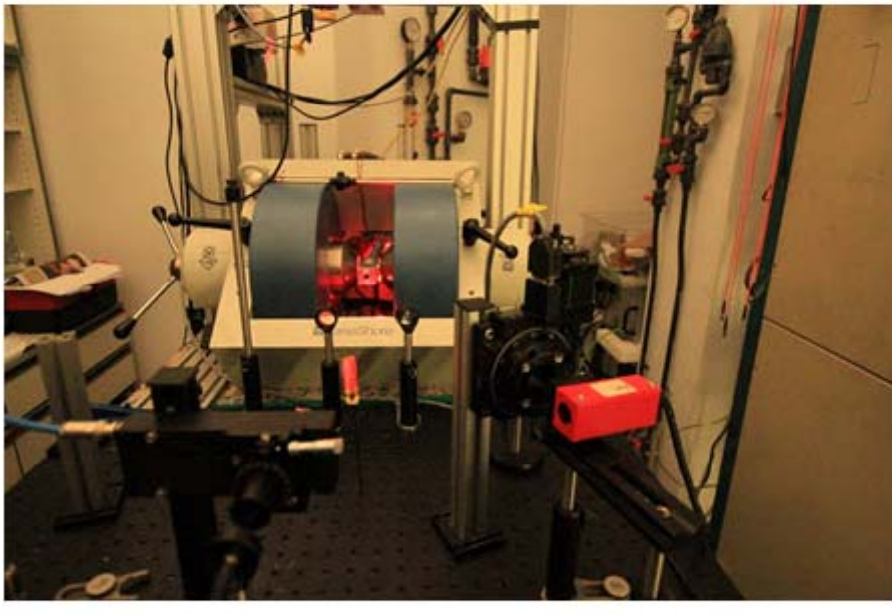
APPLIED PHYSICS LETTERS 100, 022902 (2012)

## Ferroelectric phase transition in strained multiferroic (Bi<sub>0.9</sub>La<sub>0.1</sub>)<sub>2</sub>NiMnO<sub>6</sub> thin films

E. Langenberg,<sup>1,a)</sup> I. Fina,<sup>2</sup> P. Gemeiner,<sup>3</sup> B. Dkhil,<sup>3</sup> L. Fàbrega,<sup>2</sup> M. Varela,<sup>1</sup> and J. Fontcuberta<sup>2</sup>



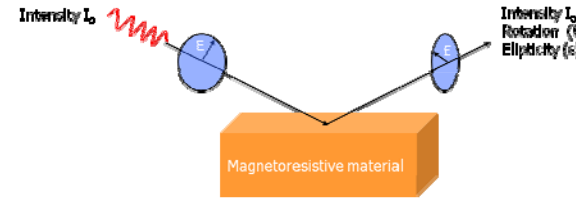
# Laboratory of Magneto-optics at ICMAB (2005-2008)



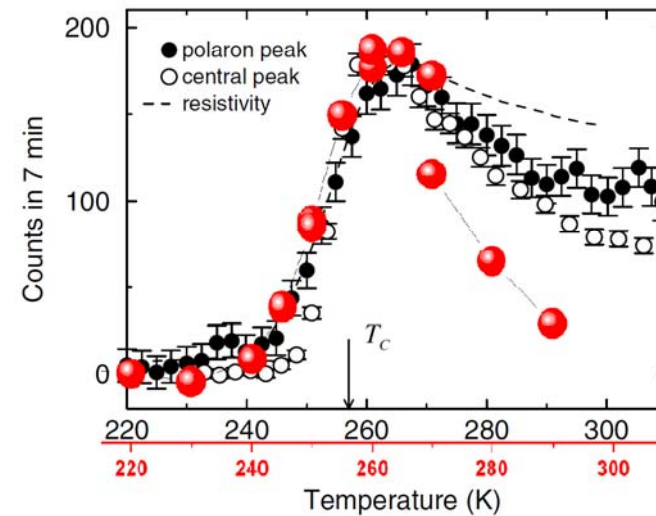
Scientific Supervisor: Dr. Gervasi Herranz  
 Technical staff: None

## Strong magnetorefractive and quadratic magneto-optical effects in $(\text{Pr}_{0.4}\text{La}_{0.6})_{0.7}\text{Ca}_{0.3}\text{MnO}_3$

J. M. Caicedo,<sup>1</sup> M. C. Dekker,<sup>2</sup> K. Dörr,<sup>2</sup> J. Fontcuberta,<sup>1</sup> and G. Herranz<sup>1,\*</sup>



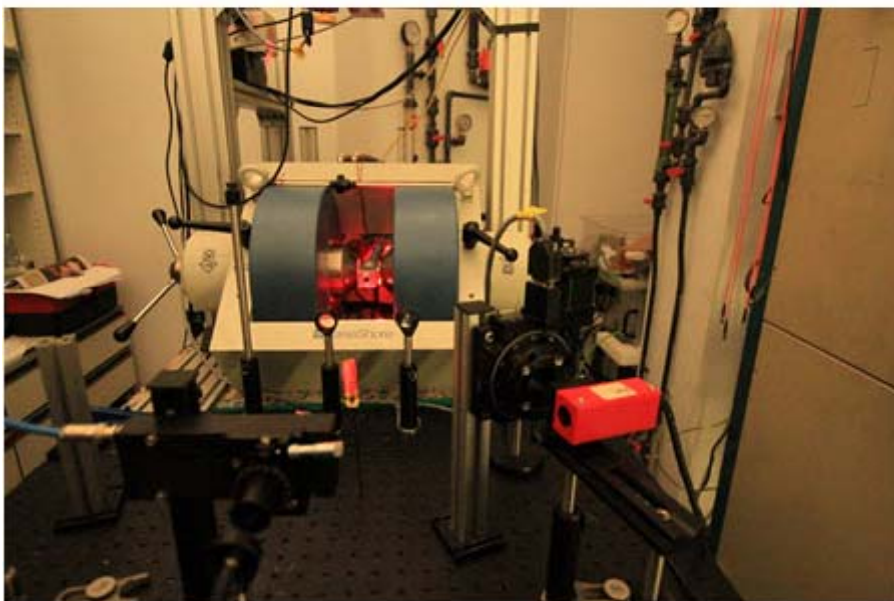
- Neutron scattering
- Magnetorefractive



## Probe of magnetopolaronic conduction at optical frequencies



# Laboratory of Magneto-optics at ICMAB (2005-2008)



Scientific Supervisor: Dr. Gervasi Herranz  
Technical staff: None

## Magnetophotonic Response of Three-Dimensional Opals

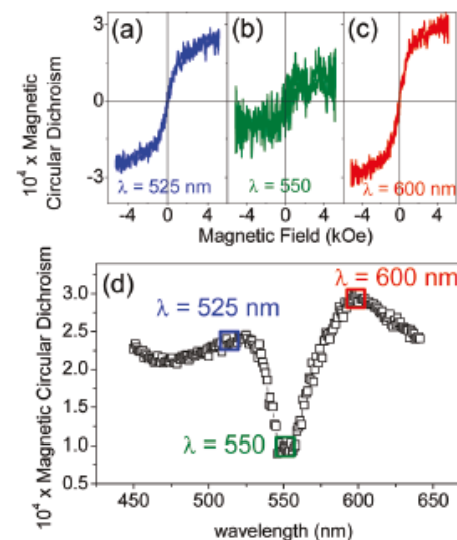
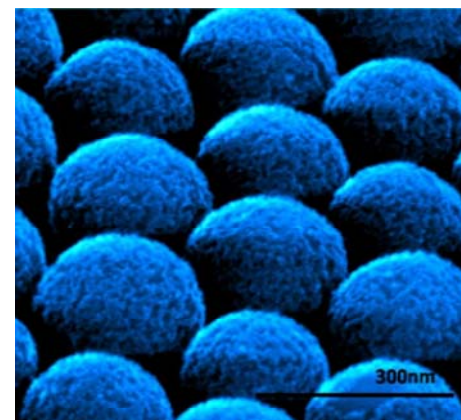
José Manuel Caicedo,<sup>†</sup> Oana Pascu,<sup>†</sup> Martín López-García,<sup>‡</sup> Víctor Canalejas,<sup>‡</sup> Álvaro Blanco,<sup>‡</sup> Cefe López,<sup>‡</sup> Josep Fontcuberta,<sup>†</sup> Anna Roig,<sup>†,\*</sup> and Gervasi Herranz<sup>†,\*</sup>

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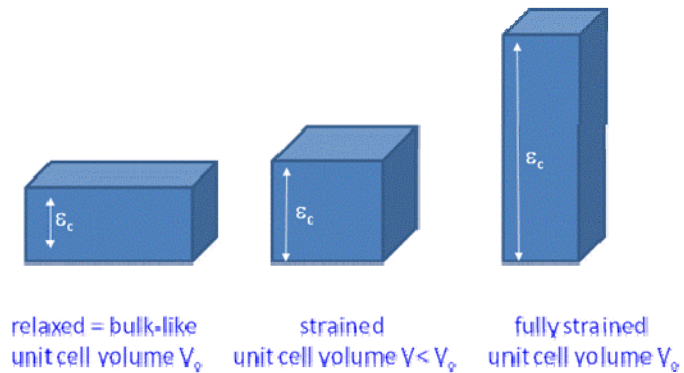
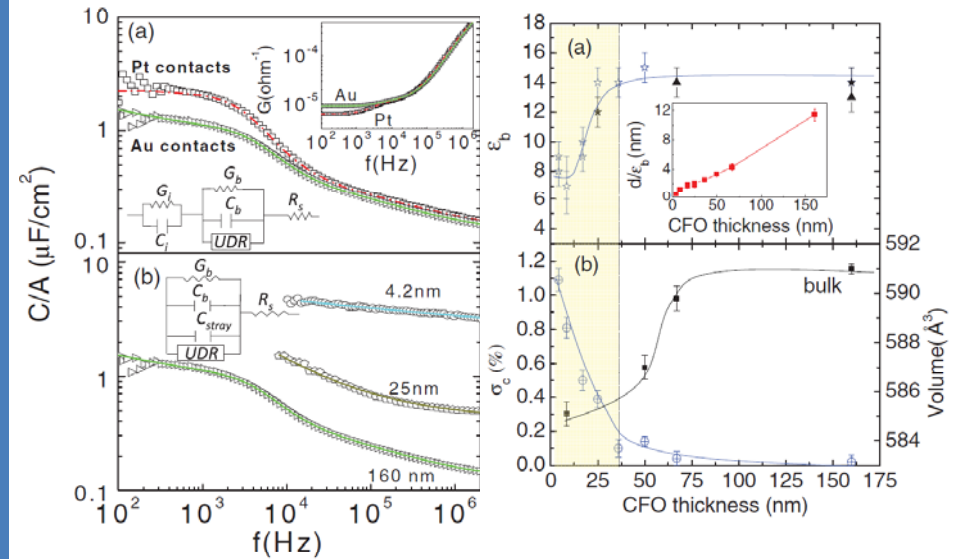
Scientific Supervisor: Dr. Florencio Sánchez  
 Technical staff: Nico Dix

## Dielectric response of epitaxially strained $\text{CoFe}_2\text{O}_4$ spinel thin films

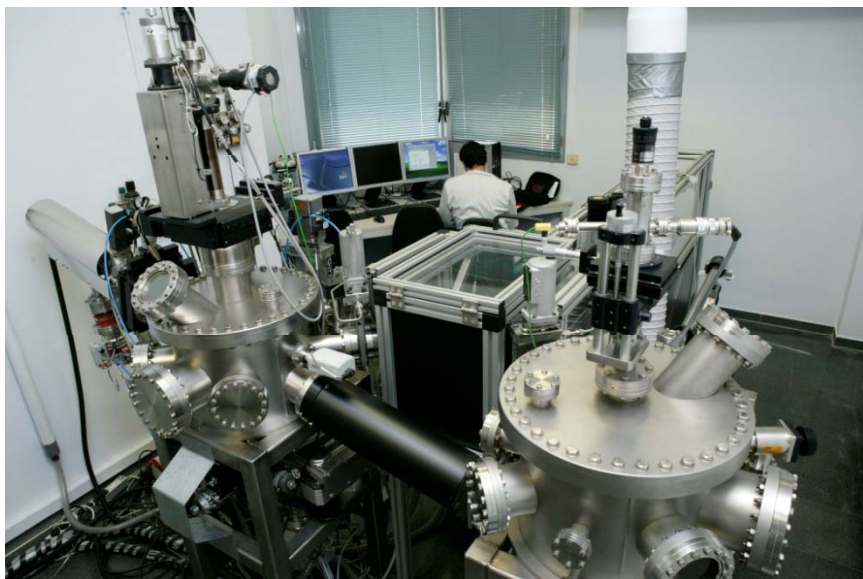
Diego Gutiérrez, Michael Foerster, Ignasi Fina, and Josep Fontcuberta  
 Institut de Ciència de Materials de Barcelona (ICMAB-CSIC), Campus UAB, Bellaterra 08193, Catalonia, Spain

Daniel Fritsch  
 H. H. Wills Physics Laboratory, University of Bristol, Tyndall Avenue, Bristol BS8 1TL, United Kingdom

Claude Ederer



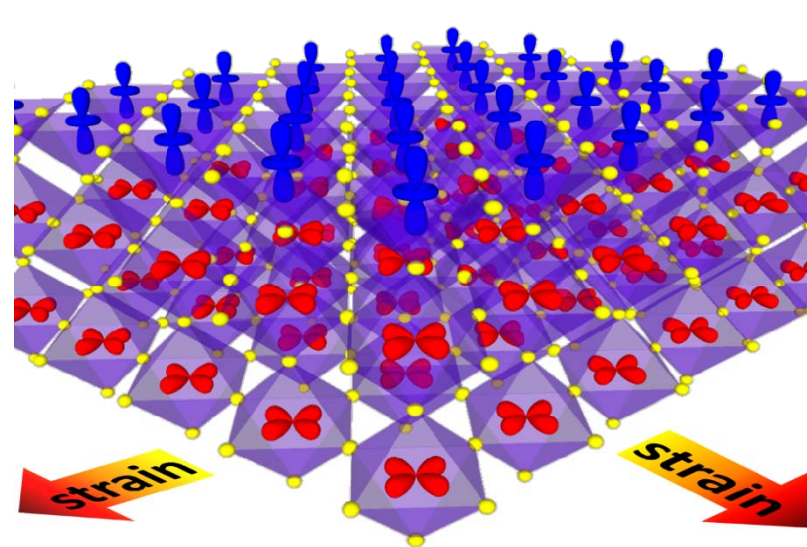
# Laboratory of Thin Films ICMAB (2011)



Scientific Supervisor: Dr. Florencio Sánchez  
Technical staff: Nico Dix

## Surface symmetry-breaking and strain effects on orbital occupancy in transition metal perovskite epitaxial films

D. Pesquera<sup>1</sup>, G. Herranz<sup>1</sup>, A. Barla<sup>2,3</sup>, E. Pellegrin<sup>2</sup>, F. Bondino<sup>4</sup>, E. Magnano<sup>4</sup>, F. Sánchez<sup>1</sup> & J. Fontcuberta<sup>1</sup>





- There are a lot of wealthy, successful Americans who agree with me:

“ if you’ve been successful, you didn’t get there on your own”.

- Let me tell you something:

“If you were successful, somebody along the line gave you some help. There was a great teacher somewhere in your life.”

“Somebody helped to create this ... ”

“Somebody invested in roads and bridges. ...”

“Somebody else made that happen. .. ”





# LABORATORY OF MULTIFUNCTIONAL THIN FILMS AND COMPLEX STRUCTURES

INSTITUT DE CIÈNCIA DE MATERIALS DE BARCELONA ICMAB-CSIC



a tots, moltes gracies

