CURRICULUM VITAE Jean-Marc TRISCONE

Personal:
Swiss citizen.
Married, two children.

Professional Address:
University of Geneva, Section de Physique, Department of Quantum Matter Physics, 24 Quai E.-Ansermet, 1211 Geneva 4, Switzerland.

Education:
University of Geneva 1982, diploma in Physics.
University of Geneva 1987, graduated with Ph.D. in physics, thesis advisor: Professor Øystein Fischer.

Thesis Title:
"Croissance et Propriétés Supraconductrices de Superréseaux Métalliques Périodiques et Quasipériodiques".

Professional experience:
1982 - 1987, Research assistant, University of Geneva.
1987 - 1990, "Maître assistant", University of Geneva.
1990 - 1991, Visiting Scientist, Dept. of Applied Physics, Stanford University, with T.H. Geballe, M.R. Beasley, and A. Kapitulnik.
1991 - 1994 "Maître assistant", University of Geneva.
February 1995 - May 1995, Visiting Scientist, Stanford University.
1996 - Full Professor of Physics, University of Geneva.
2000 - 2007 Director of the Condensed Matter Physics Department.
2001- 2007 Deputy Director of the Swiss National Center of Competence in Research MaNEP.
2004 - 2007 Vice-dean of the Faculty of science.
2007 – July 2014 Dean of the Faculty of science.
July 2015 – Vice-rector University of Geneva.

Research Activities and Interests:
Solid State physics. Low and high temperature superconductivity. Ferroelectricity. Thin films. Advanced vapor deposition techniques, epitaxial growth of metals and oxides. Artificially structured materials, epitaxial growth of metallic and oxide superlattices. Effect of reduced dimensionality, periodicity, quasi- or aperiodicity, disorder, and strain, on physical systems. Tunneling. Vortex dynamics. Search for new materials using advanced deposition techniques. Current activities are focused mainly on oxide heterostructures and oxide interface physics and engineering based on superconductors, dielectric, ferroelectric and ferromagnetic materials.

Publications:
Over 250 publications in refereed journals, (6 Science, 7 Nature, 6 Nature Materials, 7 Nature Communications, 2 Nature Nanotechnology, 1 Nature Photonics, 3 Nature Physics, 20 Physical Review Letters), over 18’500 citations, h-index 58 (source ISI Web of knowledge 2023-01-18).

Presentations:
Over 140 invited oral presentations at international conferences.

Awards and Honors
2006 - Fellow of the American Physical Society "*For his pioneering contributions in artificially layered superconducting thin film superlattices, ferroelectric field effect, and nanoscale ferroelectric writing*".
2007 - Discovery of superconductivity at the $LaAlO_3/SrTiO_3$ interface classified by Science Magazine as one of the 10 breakthroughs of the year 2007.
2008 - Ikeda prize "*For his contribution to the progress in physics of ferroelectric materials at nanoscale*".
2008 - "La Recherche" prize "*Communications and information technology*".
2013 - Awarded, with Andrea Cavalleri, Antoine Georges and Dieter Jaksch, an ERC synergy grant "*Frontiers in quantum materials control*".
2014 - Awarded, with Harold Hwang and Jochen Mannhart, the 2014 European Physical Society Condensed Matter Division Europhysics Prize "*For the discovery and investigation of electron liquids at oxide interfaces".*
2017 – Awarded a Doctor Honoris Causa from the Norwegian University of Science and Technology (NTNU), Trondheim, Norway.

Membership in Professional Associations and other activities:
Member, Swiss Physical Society.
Member, American Physical Society.
Since 2007, President of the Ernst and Lucie Schmidheiny Foundation.
Since 2009, President of the AGFA, Association de Genève des Fondations Académiques.
Since 2016, member of the Swiss Science Council.

Approved (recent) research projects
2022, SNF project: 200020_207338 "Structural and electronic coupling at oxide interfaces" – CHF 679'820.- ; 200020_231320 "Advanced x-ray diffraction investigations of functional ferroelectric domain walls" – CHF 230'000.-
2018, SNF project: 200020_179155 "Structural and electronic properties of oxide structures and oxide interfaces" – CHF 1'718'913.-
2014, ERC-Synergy grant "Q-MAC" with A. Cavalleri, A. Georges and D. Jaksch – € 2'842'368 (Geneva part).

Supervision of junior researchers (partial list)
Former PhD students: Stefano Gariglio (MER in Geneva); Thomas Tybell (Professor at NTNU, Trondheim); Patrycja Paruch (Professor in Geneva); Céline Lichtensteiger (adjointe scientifique in Geneva); Daniel Matthey (Rolex); Nicolas Stucki (lecturer at the HES Geneva); Andrea Caviglia (Professor in Geneva); Nicolas Reyren (permanent researcher at CNRS); Raoul Scherwitzl (founder and CEO of Natural cycles); Danfeng Li (Professor in Hong-Kong), Alexandre Fête (Rolex); Stéphanie Fernandez (researcher at CSEM); Jennifer Fowlie (postdoc at Stanford University); Margherita Boselli (researcher at CERN), Hugo Meley (today founding his start-up company).
Former postdocs: Charles Ahn (Professor in Yale); Danielle Marré (Professor in Genoa); Matthew Dawber (Professor in Stonybrook); Alessia Sambri (CNR Naples); Claudia Cancellieri (EMPA); Daniela Stornaiuolo (researcher University of Naples Federico II); Pavlo Zubko (lecturer at UCL); Key Takahashi (permanent researcher at Rikken); Marta Gibert (Professor at TU Wien).

Website for Triscone group :
http://dqmp.unige.ch/triscone/

Jean-Marc Triscone – Major scientific achievements

Superconductivity at interfaces between insulating oxides

In 2007, we have discovered that the ground state of the conducting interface found at the $LaAlO_3/SrTiO_3$ interface is a superconducting condensate. The critical temperature is about 300mK. Signatures of 2D superconductivity have been found and analyses of the anisotropic transport properties allow the superconducting thickness to be estimated to be about 10nm. We also succeeded tuning superconductivity with an electric field. These experiments allow superconductivity to be switched on and off and the system phase diagram to be mapped out. Our experiments have also revealed the presence of a tunable Rashba spin-orbit coupling arising from the breaking of inversion symmetry at the interface, Shubnikov-de-Haas oscillations in high mobility samples, and giant Seebeck oscillations at low doping. Recently, we studied the transport properties of nanochannels and their local optical response.

*Science **317**, 1196 (2007)*
*Nature **456**, 624 (2008)*
*Physical Review Letters **102**, 046809 (2009)*
*Physical Review Letters **104**, 126803 (2010)*
*Physical Review Letters **105**, 236802 (2010)*
*Annual Review : Condensed Matter Physics **2**, 141 (2011)*
*Physical Review Letters **107**, 056102 (2011)*
*Nature Communications **3**, 932 (2012)*
*Physical Review Letters **110**, 137601 (2013)*
*Nature Communications **6**, 7678 (2015)*
APL Materials 4, 060701 (2016) – review
*EuroPhysics Letters, **116** 17006 (2016)*
*Nature Communications **10**, 2774 (2019)*
*Physical Review Materials **4**, 035001 (2020)*

Electronic properties of nickelate films and structures

We studied epitaxial single crystal films of nickelates. We showed in $NdNiO_3$ that the metal insulator transition could be tuned by strain, electric field and light. In $LaNiO_3$, a material that is in the bulk metallic and paramagnetic at all temperatures, we showed that the insulating state observed in ultrathin films is due to weak localization and magnetic fluctuations. We studied the structure of ultrathin $LaNiO_3$ layers. We also studied the metal insulator transition in $NdNiO_3$ using PEEM and the electronic structure of nickelates with RIXS. In superlattices made of $LaMnO_3$ and $LaNiO_3$, we discovered that interfacial effects induce a magnetic structure in ultrathin $LaNiO_3$ layers and a very complex magnetic structure in superlattices with the observation of positive and negative exchange bias. We recently showed an unusual coupling of the metal insulator transitions in nickelate superlattices linked to the energy cost of having a metal-insulator phase boundary.

*Advanced Materials **22**, 5517 (2010)*
*Physical Review Letters **106**, 246403 (2011)*
*Nature Materials **11**, 195 (2012)*
*Physical Review Letters **108**, 136601 (2012)*
*Nature Materials **14**, 883 (2015)*
*Nature Communication **7**, 11227 (2016)*
*Nature communications **7**, 13141 (2016)*
*Nature Communications **7**, 13017 (2016)*
*Advanced Materials **2**, 1605197 (2017)*
*Physical Review Letters **118**, 027401 (2017)*
Reports on Progress in Physics 81, 46501 (2018) - review
*Nanoletters **19**, 4188 (2019)*
*Nature Communications **10**, 4568 (2019)*
*Nature Materials **19**, 1182 (2020)*
Nature Materials 10, 1038 (2021) – perspective

Domain wall physics in ferroelectric thin films

Using an atomic force microscope to write and read ferroelectric domain structures, varying the writing parameters, we have been able to extract the domain wall velocity as a function of the applied electric field. We have discovered that domain wall motion is a creep process. These results combined with analyses of domain wall roughness have allowed us to show that the elastic walls are two-dimensional and that the creep process is controlled by random bond disorder. More recently the depolarizing field and the role of domains were shown to be key to the phenomenon of negative capacitance.

Physical Review Letters ***89****, 097601 (2002)*
Physical Review Letters ***94****, 197601 (2005)*
APL Materials ***4****, 086105 (2016)*
Nature ***534****, 524 (2016)*
Advanced Electronic Materials ***6****, 2000852 (2020)*

Size effects in ferroelectrics

In ferroelectric materials, we have studied using different techniques including x-ray diffraction, atomic force microscopy, and x-ray photoelectron diffraction the long standing problem of size effects in ferroelectrics: Is there a minimum thickness below which ferroelectricity disappears? -A very important question for several applications. We have shown that very thin films, as thin as 3 unit-cells, of $PbTiO_3$ remain ferroelectric and that the depolarizing field, due to the imperfect screening of the polarization, is controlling the change in polarization in thin films.

Applied Physics Letters ***75****, 856 (1999)*
Science ***303****, 488 (2004)*
Physical Review Letters ***94****, 047603 (2005)*

Improper ferroelectricity at oxide interfaces

In ferroelectric/paraelectric $PbTiO_3$/$SrTiO_3$, we have shown that the ferroelectric properties can be tuned as a function of the amount of $PbTiO_3$ in the system and that, at very short wavelengths, for layer thicknesses of one or two unit cells, a new type of improper ferroelectricity appears. This ferroelectricity is related to the very unusual coupling of three order parameters, two antiferrodistortive ones which, together, break inversion symmetry allowing the further coupling to a polar mode. This phenomenon has opened the route for designing novel functionalities – such as multiferroicity - using order parameters coupling at interfaces.

Physical Review Letters ***95****, 177601 (2005)*
Advanced Materials ***19****, 4153 (2007)*
Nature ***452****, 732 (2008)*
Physical Review Letters ***104****, 187601 (2010)*
Nanoletters ***12****, 2846 (2012)*

Field effect and ferroelectric field effect

We have been developing during the years a large expertise on field effect and ferroelectric field effect experiments. On high T_c materials, we have used these techniques to modulate the system carrier density without modifying the background disorder. This approach allows a detailed study of the normal state and superconducting properties as a function of the carrier density to be realized. In doped $SrTiO_3$ and in $SrRuO_3$, we have developed the idea of the local ferroelectric field effect that allows non-volatile, reversible, electronic nanofeatures to be realized. This technique uses an atomic force microscope to control the ferroelectric polarization at nanoscale, which, via the ferroelectric field effect, permits the carrier density of the adjacent layer on the same lengthscale to be modulated. This technique was applied to control the properties of high T_c cuprate and superconducting Nb-doped $SrTiO_3$ films.

*Science **269**, 373 (1995)*
*Science **276**, 1100 (1997)*
*Science **284**, 1152 (1999)*
*Physical Review Letters **88**, 67002 (2002)*
*Nature **424**, 1015 (2003)*
*Nature **441**, 195 (2006)*
*Physical Review Letters **98**, 057002 (2007)*