Highlights

Innovative materials with strong interplay of spin orbital charge and topological degrees of freedom - 2018

Interplay between spin-orbit coupling and ferromagnetism in magnetotransport properties of a spin-polarized oxide two-dimensional electron system

D. Stornaiuolo,[1,2] B. Jouault,[3] E. Di Gennaro,[1,2] A. Sambri,[1,2] M. D'Antuono,[1] D. Massarotti,[2,4] F. Miletto Granozio,[2] R. Di Capua,[1,2] G. M. De Luca,[1,2] G. P. Pepe,[1,2] F. Tafuri,[1,2] and M. Salluzzo[2]

[1]Dipartimento di Fisica Ettore Pancini, Universitá degli Studi di Napoli Federico II, Napoli, Italy
[2]CNR-SPIN, c/o Complesso Monte Sant'Angelo via Cinthia, I-80126 Napoli, Italy
[3]Laboratoire Charles Coulomb, UMR 5221, CNRS, Université Montpellier 2, F-34095 Montpellier, France
[4]Dipartimento di Ingegneria Elettrica e Tecnologie dell'Informazione, Universitá degli Studi di Napoli Federico II, Napoli, Italy

PHYSICAL REVIEW B 98 (2018) 075409

We report on the magnetotransport properties of a spin-polarized two-dimensional electron system (2DES) formed in $LaAlO_3$ (LAO)/$EuTiO_3$/$SrTiO_3$ (STO) heterostructures. We show that, at low temperature, the 2DES magnetoconductance exhibits weak antilocalization (WAL) corrections related to Rashba spin-orbit scattering, in analogy with the LAO/STO 2DES. However, the characteristic spin-orbit scattering field decreases substantially for carrier density higher than 1.9×10^{13} cm^{-2}. We attribute this behavior to the masking effect of ferromagnetism, which sets in at the same carrier density. Thanks to the low feromagnetic temperature T_{FM} of our system (around 10K) we are able to investigate the competition between Rashba spin-orbit coupling and ferromagnetism also as a function of the temperature. Indeed, we demonstrate that WAL corrections reemerge when ferromagnetic correlations are reduced approaching T_{FM}.
Our work shows that, while weak antilocalization corrections to the magnetoconductance are strongly reduced by the emergence of ferromagnetism, they persist in a large part of the phase diagram of a spin-polarized oxide 2DES.
These results suggest that the LAO/ETO/STO 2DES, characterized by large and tunable Rashba SO coupling and magnetism, is a possible candidate for quantum spintronic applications.

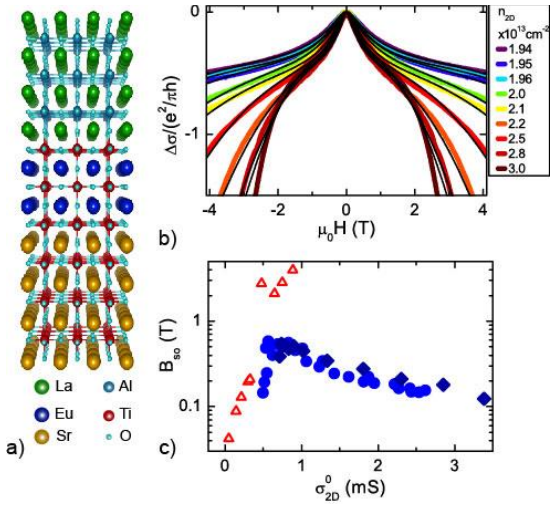

Fig.1: (a) Crystal structure of LAO/ETO/STO heterostructures. (b) Differential magnetoconductance curves versus carrier concentration. (c) Spin-orbit characteristic fields extracted from fits (blue data). The red triangles are data referring to LAO/STO samples.

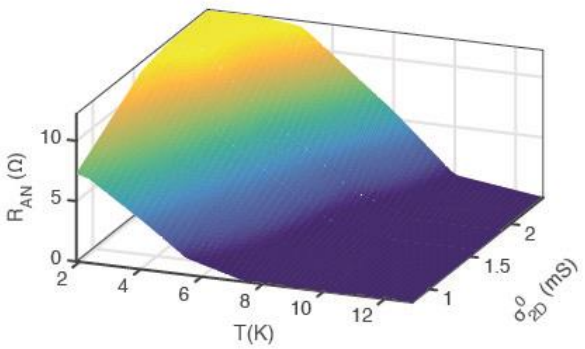

Fig. 2: Behavior of the anomalous Hall effect component R_{AN} as a function of the field effect-tuned sheet conductance (which has a one-to-one correspondence with the carrier concentration) and of the temperature. R_{AN} is due to the presence of ferromagnetic correlations in the 2DES.