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## Superconductivity, ferromagnetism and Rashba spin-orbit coupling in oxide 2DES

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Two dimensional electron systems (2DES) formed at the interface between insulating transition metal oxides have demonstrated an extraordinary range of properties. The coexistence among these properties can be studied via electric field effect, making these systems an ideal test bench for the investigation of novel quantum phenomena. A notable example is the coexistence between superconductivity and Rashba spin-orbit coupling in the 2DES at the interface between LaAlO<sub>3</sub> and SrTiO<sub>3</sub> (LAO/STO). We will review the recent remarkable progresses in realization of complex LAO/STO superconducting nanodevices and focus on indications of an unconventional superconducting order parameter obtained in LAO/STO Josephson junctions [1]. Moreover, thanks to the introduction of a delta-doping layer of EuTiO<sub>3</sub> sandwiched between STO and LAO, ferromagnetic correlations were recently added to this picture [2]. We will present a study of the interplay between ferromagnetism and Rashba spin-orbit coupling in LAO/ETO/STO heterostructures performed by analyzing the magnetotransport data as a function of the carrier density and of the temperature [3]. We will show also that the ferromagnetic correlations in this system can be tuned by light illumination.

[1] G.Cheng et al., Nature 521, 196 (2015); L. Kuerten et al., Phys. Rev. B 96, 014513 (2017); G.E.D.K Prawiroatmodjo et al., Nat. Comm. 8, 395 (2017), D. Stornaiuolo et al., Physical Review B, 95, 140502(R) (2017) [2] D. Stornaiuolo et al., Nature Materials 15, 278-283 (2016). [3] D. Stornaiuolo et al., Physical Review B 98 (7), 075409 (2018)

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