# Ferromagnetic and Superconducting oxides 2DEGs systems

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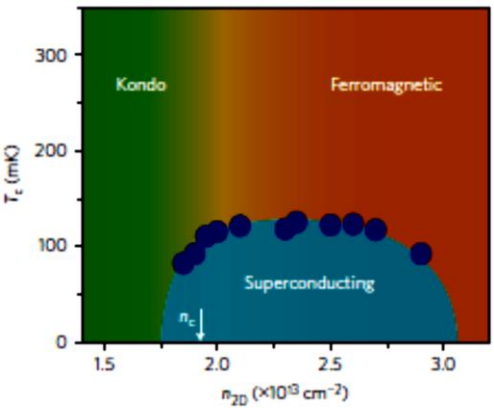
In 2004 Ohtomo and Hwang [1] reported on the formation of a high mobility 2-dimensional electron gas (2DEG) at the interface between two wide bandgap insulators oxides, namely $LaAlO_3$ (LAO) and $SrTiO_3$ (STO). This work stimulated a large interest in the scientific community.
Recently, we demonstrated that the 2DEG created at the LAO/STO interface becomes spin polarized by introducing a few unit cells of delta doping $EuTiO_3$ (ETO), an antiferromagnetic (AF) insulator iso-structural to STO [2,3].
The occurrence of magnetic interactions, superconductivity and spin-orbit interactions in the same tunable 2DEG system makes the LAO/ETO/STO an intriguing platform for the emergence of novel quantum phases in low-dimensional devices.
In this work we show how the rich phase diagram of this 2DEG can be tuned by electric field and by light.
Firstly, have investigated the interplay between ferromagnetism and Rashba spin-orbit interactions by studying the magnetoconductance curves of the 2DEG as a function of the applied gate voltage and temperature. In fact, the LAO/ETO/STO is one of the few systems where such interplay can be studied [4].
Under visible light, moreover, the interface exhibits a persistent photoconductivity and the magnetotransport measures shows also an anomalous Hall effect. This feature is probably related to different the nature of the photo-excited spin-polarized 4f carriers due to ETO [5].

These results suggest that the LAO/ETO/STO spin-polarized 2DEG system is a possible candidate for new quantum spintronic applications.




Temperature versus carrier density phase diagram of the **LAO/ETO/STO** Heterostructure [3].

**References**
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