Oxide interfaces

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The rich physics of transition metal oxides resulting in this wide variety of properties is related to the delicate balance between charge, spin and orbital degrees of freedom. This large diversity is observed in materials, mainly of the perovskite family having similar structure and lattice constant, allowing for the growth of heterostructures with very high structural quality. Using modern synthesis methods, it is now possible to engineer interfaces between complex transition metal oxides with an atomic-scale precision. Interfaces break the symmetry, induce stresses, consequently altering the distances and bonds between the ions and giving rise to changes in bandwidths, interactions and in energy levels degeneracy, therefore possibly modifying the electronic phase of these materials. Tailoring and controlling (taking advantage of the sensitivity of these new phases to external stimuli) the physical properties at these interfaces between different oxide materials thus provides a new playground for researchers and offers a new nanoelectronics fabrication platform for future electronics and spintronics.

In this lecture I will introduce the topic of oxide interfaces and the different mechanisms for interface reconstruction. I will then describe its most emblematic member, $LaAlO_3/SrTiO_3$. I will discuss the mechanism for the formation of the two-dimensional electron gas (2DEG) at this interface and present its transport properties (in the normal and superconducting regime) and notably its unconventional Rashba spin-orbit coupling. Finally, I will present other types of oxide interfaces with charge reconstruction, and their resulting novel transport magnetic properties.

References:

M. Bibes, J.E. Villegas and A. Barthélémy, *Ultrathin oxide films and interfaces for electronics and spintronics* Adv. Mater. 60, 5 (2011)

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