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Interfacial Effects in Oxide Heterostructures

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Abstract

Oxide materials display within the same family of compounds a variety of exciting electronic properties ranging from ferroelectricity to ferromagnetism and superconductivity. These systems are often characterized by strong electronic correlations, complex phase diagrams and competing ground states. This competition makes these materials very sensitive to external parameters such as pressure or magnetic field. An interface, which naturally breaks inversion symmetry, is a major perturbation and one may thus expect that electronic systems with unusual properties can be generated at oxide interfaces [1,2]. A striking example is the interface between $LaAlO_3$ and $SrTiO_3$, two good band *insulators*, which was found in 2004 to be conducting [3], and, in some doping range, superconducting with a maximum critical temperature of about 200 mK [4].
In this presentation, I will motivate the search for novel properties at oxide interfaces. I will then focus on the $LaAlO_3/SrTiO_3$ system and discuss superconductivity, the phase diagram of the system [4,5] and the link with doped bulk $SrTiO_3$; spin orbit and recent experiments on nanostructures that reveal a remarkable tuning of the electronic properties and allow weak localization and weak anti-localization as a function of doping and temperature to be followed [6,7]. Finally, I will discuss an approach that should allow superconducting coupling between different gases to be studied.
If time allows, I will also talk about nickelate-based heterostructures that are attracting a lot of attention [see, for instance, 8,9]. In such structures, charge transfer and charge ordering phenomena may induce novel properties as recently observed in (111) $LaNiO_3/LaMnO_3$ superlattices where evidence for exchange bias was found. In this particular case, this indicates that a magnetic order is induced in the paramagnetic $LaNiO_3$ material when embedded between ferromagnetic $LaMnO_3$ layers [10].

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