Novel 2D electron gases at the surface of transition-metal oxides

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Abstract

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Transition-metal oxides (TMOs) are correlated-electron systems presenting remarkable properties, such as high-temperature superconductivity or multi-ferroic behaviour. The realization of two-dimensional electron gases (2DEGs) at surfaces or interfaces of TMOs, a field of current active research [1], is crucial for harnessing the functionalities of these materials in view of future applications. From a fundamental point of view, these 2DEGs offer the possibility to explore new physics emerging from the combined effects of electron correlations and low-dimensional confinement.

Recently, we discovered that a 2DEG can be simply realized at the vacuum-cleaved surface of SrTiO3, a *transparent, insulating* TMO with a large gap of 3.5 eV, and directly imaged its multiple heavy and light subbands using angle-resolved photoemission spectroscopy [2]. In this talk, I will show that such a procedure can be generalized to obtain and tailor 2DEGs in other TMOs, opening a wide realm of possibilities for the study of correlations in low dimensions in materials showing diverse functionalities. I will first discuss the specific case of KTaO3, a wide-gap insulator with a spin-orbit coupling about 30 times larger than in SrTiO3. I will show that quasi-2D confinement in this system results in comparable scales for the Fermi energy, the subband splitting, and the spin-orbit coupling, leading to a complete reconstruction of the *orbital symmetries* and band masses [3]. Then, I will show that the electronic structure of the 2DEGs at the surface of TMOs can be wholly modified by choosing several surface terminations of different symmetries [4]. All together, these results demonstrate that, in TMOs, the strong correlations, combined with the electron confinement and the surface-lattice symmetry, can lead to novel states at the surface that are not simple extensions of the bulk bands.

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