Unveiling 2D electron gases in functional oxides using synchrotron radiation

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Transition-metal oxides (TMOs) show remarkable properties, not found in standard semiconductors, such as high-temperature superconductivity or metal-to-insulator transitions. The realization of two-dimensional electron gases (2DEGs) in TMOs is crucial for harnessing the functionalities of these materials for future applications. Additionally, such 2DEGs offer the possibility to explore new physics emerging from the combined effects of electron correlations and low-dimensional confinement.

In this talk, I will first introduce our discovery, using angle-resolved photoemission spectroscopy with UV synchrotron light, that 2DEGs can be simply realized at the surface of various insulating TMOs, such as the quantum paraelectric $SrTiO_3$ [1], the strong spin-orbit coupled $KTaO_3$ [2], or the photo-catalyst TiO_2 [3]. Then, I will show how the choice of the surface termination allows tailoring the electronic structure and symmetries of these 2DEGs [4-5], paving the way for the quest of topological states in correlated oxides. Furthermore, I will discuss our studies of magnetism in the 2DEG at the surface of oxygen-deficient $SrTiO_3$ [6]. Finally, I will describe our recent development of a simple universal method to fabricate these 2DEGs in several other oxides, such as the ferroelectric $BaTiO_3$, which allows measuring its transport characteristics –and is thus promising for the realization of oxide devices [7].

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