Interplay of orbital ordering, spin-orbit coupling and many-body interactions in the $SrTiO_3$ 2D electron gas

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Two-dimensional electron gases (2DEGs) spontaneously formed at the interface between two band insulators, $SrTiO_3$ and $LaAlO_3$, have become model systems for engineering emergent behaviour in complex transition metal oxides.[1] Understanding the collective interactions that enable this, however, has thus far proved elusive. I will describe our work developing methodologies to write such 2DEGs at the bare surface of $SrTiO_3$ *via* control of the surface stoichiometry.[2,3] This allows us to utilize angle-resolved photoemission to directly image the quasiparticle dynamics of the *d*-electron subband ladder of this complex-oxide 2DEG.[4] Combined with realistic tight-binding supercell calculations, we uncover how quantum confinement and inversion symmetry breaking collectively tune the delicate interplay of charge, spin, orbital, and lattice degrees of freedom in this system. We demonstrate how they lead to a pronounced orientation-dependent orbital ordering, mediate orbitally-enhanced Rashba splitting and complex spin-orbital textures, and markedly change the character of electron-phonon coupling, co-operatively shaping the low-energy electronic structure of the 2DEG.

References

1. Hwang, H. Y. *et al. Nat. Mater.* **11**, 103 (2012)
2. Meevasana W., King, P.D.C. *et al. Nat. Mater.***10**, 114 (2011)
3. McKeown Walker, S. *et al. arXiv* 1405.3201 (2014)
4. King, P. D. C. *et al. Nat. Commun.* **5**, 3414 (2014)

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